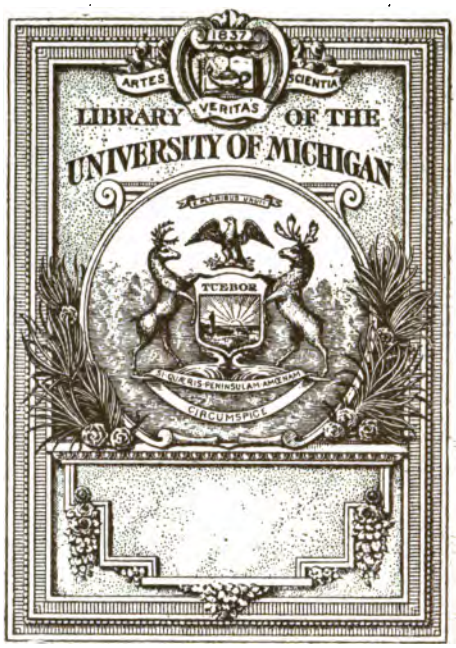
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SOME GREAT COMMODITIES

SOME GREAT COMMODITIES

By

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GARDEN CITY NEW YORK
DOUBLEDAY, PAGE & COMPANY
1922

PRINTED IN THE UNITED STATES
AT
THE COUNTRY LIFE PRESS, GARDEN CITY, N. Y.

NOTE

This book presents studies of ten great commodities which occupy an important place in the economic life of the United States and in the international trade of the world. Originally appearing in *Commerce Monthly*, a journal of commerce and finance published by the National Bank of Commerce in New York, these studies occasioned so much interest that they have been made the subject of more elaborate investigations which are now presented here in permanent form. Consideration has been given to government reports and recognized trade sources in making the exhaustive studies upon which these articles are based.

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SOME GREAT COMMODITIES

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COAL

ADEQUATE coal supplies are of fundamental importance to every industrial country. The whole structure of modern production has been built on coal as a cheap source of power. In spite of the development in the use of water power and of petroleum and its products, the position of coal as the main source of industrial power is unchallenged.

Coal is widely distributed throughout the world and few countries are without at least a small supply. The resources of the various countries, however, differ widely in commercial value because of variations in the quality of the coal and in the degree of ease with which it can be mined and marketed. Fairly complete surveys of the coal resources of Europe and of the United States and Canada have been made, but as to the remainder of the world, knowledge of both the extent of the fields and the quality of the coal is imperfect.

So gradual is the evolution of coal through all the stages from peat to graphite that it is difficult clearly to define its different grades. The United States Geological Survey, however, divides coal into six classifications, namely, lignite, sub-bituminous, bituminous, semi-bituminous, semi-anthracite and anthracite. For all practical purposes this classification is simplified into three groups, anthra-

cite, bituminous and lignite. The chief use of anthracite is for domestic purposes, the smaller sizes being used for steam coal. The great bulk of the world's coal is bituminous or "soft" coal. It is the chief steam coal; it is essential for coke manufacture and consequently for the production of iron and steel, and it is also used widely as a domestic fuel. Lignite is commonly known as brown coal, although all deposits are not of this color. It is heavy in moisture when taken from the mines, the amount of moisture generally ranging from 30 to 40 per cent., and in consequence is of low heating value. This extra weight and inferior heating value make it impracticable to ship lignite any great distance. When exposed to the weather lignite dries and falls to pieces rapidly, and it is more likely than other coals to ignite spontaneously.

COAL RESOURCES OF THE WORLD

The world's known coal resources aggregate about 7,260 billion gross tons. Of this, 69 per cent. is in North America, 17 per cent. is in Asia, 11 per cent. in Europe and 2 per cent. in Oceania. Africa and South America contain relatively unimportant deposits. The latest available figures for the resources of the world by countries, which are shown below in Table A, were compiled on the initiative of the Twelfth International Geological Congress and were published in 1913. Although the data were undoubtedly for a year or two prior to that date, the exhaustion of coal which occurs in two or three years is relatively so small that the estimates may be considered approximately correct as of 1913.

Since 1913 further deposits have been found in western Canada, Russia, China and in other countries but reliable

data as to their extent are not available. Explorations are being carried on in South America, Asia, Africa and Oceania, and such activities have been greatly stimulated by the high price of coal and the difficulty of obtaining it in recent years. While definite data are not yet available as to the results of this recent work, it is certain that many valuable coal areas are as yet unknown or their possibilities uncalculated.

The war has occasioned some important changes in the political distribution of coal resources. From Germany, France has obtained the coal in Alsace-Lorraine and the Saar Basin—the former unconditionally, the latter for a period of fifteen years with the possibility (subject to a plebiscite) of repurchase by Germany at the end of that period. The extensive coal field lying at the juncture of the former German, Austrian and Russian Empires has also been redistributed. Those parts lying within German and Russian Poland and Austrian Galicia have gone to Poland. The remainder of the Austrian portion now lies in Czechoslovakia. The ownership of the richest portion of the field, which lies in Upper Silesia, is divided between Germany and Poland, the bulk of the reserves being assigned to the latter country. The Austrian Empire has also lost the deposits in Dalmatia, Bosnia and Herzegovina to Jugoslavia.

The data shown in Table A indicate the aggregate resources possessed by the respective countries prior to the war. For those countries (Germany, Austria and Russia) the reserves of which have been seriously diminished in consequence of the war, resources are given in detail to facilitate an estimate of their changed position. Quantities are stated in millions of gross tons and no allowance

TABLE A—COAL RESOURCES OF THE WORLD

Country	Total	Anthracite (millions of gross tons)	Bituminous (millions of gross tons)	Lignite
Australasia				
Australia	*162,928*	*649*	*130,161*	*32,118*
New Zealand	*3,333*	...	*897*	*2,436*
Total	166,261	649	131,058	34,554
Austria-Hungary				
Bohemia and Silesia (1)	*15,400*	...	*3,422*	*11,978*
Galicia (2)	*24,507*	...	*24,507*	...
Dalmatia, Bosnia and Herzegovina (3)	*3,632*	...	...	*3,632*
Hungary	*1,690*	...	*111*	*1,579*
Other districts	*13,105*	...	*12,406*	*699*
Total	58,334	...	40,446	17,888
Belgium	10,826	...	10,826	...
Canada and Newfoundland	1,215,268	2,124	279,673	933,471
Chile	3,000	...	3,000	...
China	979,864	381,345	597,928	591
Colombia	26,574	...	26,574	...
Dutch East Indies	1,290	...	236	1,054
France	17,305	3,219	12,480	1,606
Germany				
Saar (4)	*16,287*	...	*16,287*	...
Upper Silesia (5)	*163,365*	...	*163,365*	...
Westphalia (Ruhr)	*210,193*	...	*210,193*	...
Other districts	*26,825*	...	*13,655*	*13,170*
Total	416,670	...	403,500	13,170
India	77,753	...	75,192	2,561
Indo-China	19,686	19,686	...	...
Japan	7,844	61	7,017	766
Netherlands	4,333	315	4,018	...
Persia	1,829	...	1,829	...
Peru	2,007	689	1,318	...
Russia, European				
Dombrova (6)	*2,485*	...	*2,485*	...
Other districts	*56,672*	*37,005*	*18,035*	*1,632*
Total	59,157	37,005	20,520	1,632
Russia, Asiatic	171,132	...	64,991	106,141
Spain	8,629	1,609	6,265	755
Spitzbergen	8,612	...	8,612	...
Union of South Africa	55,313	11,476	43,837	...
United Kingdom	186,540	11,178	175,362	...
United States (7)	3,756,277	16,686	1,918,310	1,821.281
Other countries	4,462	270	1,984	2,208
Grand total (7)	7,258,966	486,312	3,834,976	2,937,678

[1]Now included in Czechoslovakia. [2]Now included in Poland. [3]Now included in Jugoslavia. [4]Now under French control. [5]Divided between Poland and Germany; about 86 per cent. of reserves estimated as assigned to Poland and 14 per cent. to Germany. [6]Now included in Poland. [7]Revised on basis of latest estimates by U. S. Geological Survey of original coal resources of the United States, and grand total revised correspondingly.

is made for waste in mining or for quantities of coal not easily minable.

COAL RESOURCES OF THE UNITED STATES

More than half of the total coal resources of the world, it will be observed from Table A, are located in the United States. The long lead as regards quantity which its coal deposits hold over those of other countries is best illustrated by the fact that while they constitute 52 per cent. of world resources, Canadian deposits, which rank next in size, are only 17 per cent. of the world total. Reserves of the United States at the beginning of 1919 are estimated at 3,752,044 million tons. While of the total available supply nearly one-half is lignite, this unfavorable factor is offset by the wealth of bituminous coal, so essential to industrial development. Reserves of bituminous in the United States constitute slightly more than half of the world's total of this class. Reserves of anthracite in the United States, on the other hand, are smaller than those of China, European Russia or Indo-China.

Considered from the standpoint of quantity only, the western part of the United States contains far greater coal reserves than the eastern section of the country. The United States Geological Survey divides the coal-bearing areas of the United States into six main provinces. The total coal deposits of the three western areas designated as the Northern Great Plains, Rocky Mountain and Pacific Coast provinces, far exceed the amount of coal in the two eastern provinces. However, it is in the eastern and interior provinces, with their relatively limited supplies, that the real wealth of coal lies. With the exception of a very small amount, all of the anthracite is in the East,

and, what is far more important, the best steaming coal is confined to these two eastern provinces.

It is these valuable coals which are being exhausted most rapidly. In the two eastern provinces the exhaustion of coal to the end of 1918 is estimated at approximately 13,828 million tons compared with 1,457 million tons for all the rest of the country. Table B, based on the most recent estimates of the United States Geological Survey, shows the original coal resources of the United States and resources at the beginning of 1919.

RESOURCES OF OTHER COUNTRIES

While Canada ranks second in aggregate coal resources, the bulk of its deposits consists of lignite, which is of secondary commercial importance. Even so, its bituminous reserves rank fourth in extent. China possesses unsurpassed stores of anthracite, while its bituminous reserves are second only to those of the United States. Exploitation of Chinese resources, however, has as yet scarcely begun and they constitute the great reserves of the more distant future. Asiatic Russia likewise has extensive but almost unknown deposits. In Australia are rich supplies capable of extensive development. The major coal resources of Europe are comprised in four great fields, the political control of which is divided among a number of powers. These coal fields are—first, the fields in the British Isles; second, the Rhine Valley fields including the Ruhr Basin in Germany, the Saar Basin, formerly German and now under French control, the Namur fields in Belgium and the fields in the Nord and Pas de Calais Departments of France; third, the fields at the juncture of Germany, Poland and Czechoslovakia,

Table B—Estimated Original Coal Resources of the United States; and Resources at Beginning of 1919[1]

Province	Original Coal Resources: Anthracite	Bituminous	Lignite	Total	Coal Resources at Beginning of 1919
	(in millions of gross tons)				
Eastern—Penn. and the Atl. Coast and Appal. regions, inc. Ohio, W. Va., eastern Ky. and parts of Ala. and Tenn. ..	18,795	492,810	...	511,605	500,762
Interior — Mich., Ill., Ind., western Ky., Iowa, Kan., Okla., Mo., Ark. and southwest...	357	472,767	...	473,124	470,139
Gulf — Mined only in Tex., but found as far north as Cairo, Ill., and east to Ala.	...	...	20,616	20,616	20,596
Northern Great Plains — From N. Dak. and Mont., south to New Mex., inc., the Denver and Raton Mesa regions	...	40,672	1,115,154	1,155,826	1,155,452
Rocky Mountains—Bighorn, Wind River, Ham's Fork, Green River, Uinta, southwest Utah and San Juan regions.........	448	909,952	637,808	1,548,208	1,547,265
Pacific Coast—Coals in extreme western part of country, chief field being in Wash..........	7	10,213	47,730	57,950	57,830
Total.....	19,607	1,926,414	1,821,308	3,767,329	3,752,044

[1]Includes deposits of coal within 3,000 feet of surface except that in the Rocky Mountain province, 595 billion tons of bituminous coal from 3,000 to 6,000 feet below surface have been included.

the richest portion of which lies in Upper Silesia; and fourth, the Donetz Basin, bordering the Black Sea, in Russia. It is only in the industrial countries of western Europe, which collectively possess less than 10 per cent. of total world reserves, that full utilization of coal resources is yet being made.

UTILIZATION OF COAL RESOURCES

There is a striking divergence among various countries as regards their relative utilization of coal reserves. This is indicated in Table C, which compares resources with production in 1913, the latest year of normal production. The United Kingdom, the coal production of which ranks second only to that of the United States, and which in 1913 supplied nearly one-fourth of the world's total production, possesses less than three per cent. of the aggregate coal resources. Germany, with deposits amounting to only 6 per cent. of the world's resources, in 1913 supplied over one-fifth of the total output of coal. Among Asiatic

TABLE C—UTILIZATION OF COAL RESOURCES

Country	Production in 1913 Millions of tons	Production in 1913 Per cent. of total	Resources Millions of tons	Resources Per cent. of total
United States	509	38.6	3,756,277	51.8
United Kingdom	287	21.7	186,540	2.6
Germany	273	20.7	416,670	5.7
Austria-Hungary	53	4.0	58,334	.8
France	40	3.0	17,305	.2
Russia (European)	33	2.5	230,289	3.2
Belgium	22	1.7	10,826	.1
Japan	21	1.6	7,844	.1
India	16	1.2	77,753	1.1
China	14	1.1	979,864	13.5
Canada	13	1.0	1,215,268	16.8
Australia	12	.9	162,928	2.2
Other countries	27	2.0	139,068	1.9
Total	1,320	100	7,258,966	100

countries, Japan possesses the smallest resources and produces the most coal. Canada and China, on the other hand, with 17 per cent. and 14 per cent. respectively of the world's resources, each supplied but 1 per cent. of the total coal output.

COAL PRODUCTION OF THE WORLD

The steady and rapid expansion of world coal output prior to the war is a close index of the remarkable development of modern industrial activity. A half century ago, production aggregated 211 million gross tons; by 1900 it had increased to 755 million tons, and by 1913, to 1,321 million tons. While the annual increase in output varied considerably, it had been growing consistently and for some years prior to 1913 averaged more than 50 million tons per year.

This expansion of world production was ended by the war. Since 1913 not only has the yearly increase been lost but there has been a positive decline in coal production. Estimated world production in 1920, a year of intense demand, was 25 million tons less than the output of 1913. The difference between the actual output of 1920 and the potential output had the pre-war rate of increase continued, amounts to nearly 400 million tons. This huge disparity is a graphic indication of the tremendous industrial disorganization wrought by the war, which reduced the world's capacity not only to produce coal but to consume it.

Beyond such impairment, however, practically all industrial countries were suffering from a shortage of coal below actual physical requirements, and this shortage by 1920 was reaching an acute stage when the abrupt reaction of commerce and industry further reduced coal consump-

TABLE D—WORLD PRODUCTION OF COAL* (INCLUDING

Country	*1913*	*1914*	*1915*
North America—Canada—*Coal*	[1]	[1]	*10,253*
Lignite	[1]	[1]	*1,592*
Total	13,404	12,176	11,845
Mexico	877[2]	689[2]	591[2]
United States	508,890	458,502	474,658
South America—Brazil	15[2]	30[2]	59[2]
Chile	1,263	1,070	1,153
Peru	270	279	286
Europe—Austria—*Coal*	*16,200*	*15,301*	*15,829*
Lignite	*26,946*	*23,208*	*21,669*
Total	43,146	38,509	37,498
Belgium	22,481	16,450	13,954
Bulgaria	352	415	525
Czechoslovakia—*Coal*	[4]	[4]	[4]
Lignite	[4]	[4]	[4]
Total	[4]	[4]	[4]
France[5]	40,199	27,093	19,224
Germany[6]—*Coal*	*187,107*	*158,836*	*144,548*
Lignite	*85,855*	*82,372*	*86,559*
Total	272,962	241,208	231,107
Greece	[7]	20	39
Hungary—*Coal*	*1,299*	*1,098*	*1,080*
Lignite	*8,813*	*7,932*	*8,035*
Total	10,112	9,030	9,115
Italy—*Coal*	*1*	*1*	*9*
Lignite	*686*	*766*	*924*
Total	687	767	933
Jugoslavia	306[10]	197[11] [10]	197[11] [10]
Netherlands—*Coal*	*1,843*	*1,898*	*2,226*
Lignite	...	...	...
Total	1,843	1,898	2,226
Poland	[3]	[3]	[3]
Portugal	25	29	39
Rumania	237	268	304
Russia (European)	33,280	32,665	30,167
Spain—*Coal*	*3,952*	*4,068*	*4,290*
Lignite	*273*	*287*	*323*
Total	4,225	4,355	4,613
Spitzbergen	34	39	28
Sweden	358	361	406
Switzerland	...	...	39[2]
United Kingdom	287,431	265,665	253,209
Asia—British India	16,208	16,464	17,104
China	13,561	9,126	17,716
Chosen	126	180	225
Federated Malay States	[3]	[3]	12
Indo-China	423	610	634
Japan	21,397	22,402	20,673
Russia (Asiatic)	2,128	2,415	2,212
Turkey	829	651	489
Africa—Rhodesia	243	349	410
Union of South Africa	8,801	8,478	8,281
Oceania—Australia	12,418	12,445	11,415
British Borneo	98	99	115
Dutch East Indies	559	612	609
New Zealand	1,886	2,204	2,209
Estimated World Production	1,321,000	1,188,000	1,175,000

*In thousands of gross tons.
[1] Not reported separately.
[2] Estimated.
[3] Not available.
[4] Included in production for Austria and Hungary. Production in territory now included in Czechoslovakia was, in 1913, coal 14,046,000, lignite 22,653,000, total 36,699,000 tons.
[5] Beginning with 1920, production of Saar district has been included with that of France. Saar output in 1920 was 9,261,000 tons and in 1921, 9,669,000 tons.

LIGNITE) BY PRINCIPAL COUNTRIES, 1913 TO 1921

1916	1917	1918	1919	1920	1921
10,904	*10,056*	*10,492*	*9,602*	*11,626*	*10,468*
2,028	*2,486*	*2,881*	*2,613*	*3,224*	*2,873*
12,932	12,542	13,373	12,215	14,850	13,341
492[3]	492[3]	424	683	[8]	[8]
526,871	581,606	605,543	494,598	576,745	441,515
98[3]	98[3]	98[3]	[8]	[8]	[8]
1,396	1,515	1,493	1,314	1,044	[8]
302	340	326	325	355	[8]
17,324	*16,465*	*14,084*	*89*	*131*	*136*
22,833	*21,284*	*17,825*	*1,975*	*2,371*	*2,360*
40,157	37,749	31,909	2,064	2,502	2,495
16,597	14,696	13,672	18,191	22,035	21,463
630	749	662	568	745	738
[4]	[4]	[4]	*9,710*	*10,967*	*11,464*
[4]	[4]	[4]	*16,811*	*19,629*	*20,718*
[4]	[4]	[4]	26,521	30,596	32,182
20,974	28,459	25,844	22,087	34,162	38,187
156,656	*165,098*	*155,755*	*114,864*	*129,273*	*133,641*
92,693	*94,034*	*99,010*	*92,167*	*109,871*	*121,068*
249,349	259,132	254,765	207,031	239,144	254,709
115	155	157[3]	180	180	132
[1]	*1,202*	[1]	[1]	[1]	[1]
[1]	*7,490*	[1]	[1]	[1]	[1]
8,858[3]	8,692	7,874[3]	3,840	4,885	5,948
18	*45*	*32*	*109*	*149*	*110*
1,263	*1,631*	*2,084*	*1,111*	*1,547*	*1,003*
1,281	1,676	2,116	1,220	1,696	1,113
197[3] [10]	197[3] [10]	248[10]	2,458	3,173	[8]
2,614	*2,960*	*3,346*	*3,484*	*4,050*	*4,102*
..	*42*	*1,459*	*1,852*	*1,374*	*120*
2,614	3,002	4,805	5,336	5,424	4,222
[8]	[8]	[8]	6,164[9]	6,555[9]	6,995[9]
49[8]	59[8]	89[8]	144	166	[8]
295[3]	295[3]	295[3]	1,516	1,481	[8]
31,003[3]	27,951[3]	14,451	6,361	6,065	9,695
4,771	*4,962*	*6,409*	*5,614*	*5,335*	*4,932*
466	*628*	*715*	*531*	*544*	*402*
5,237	5,590	7,124	6,145	5,879	5,334
20	39	59	87	118	[8]
408	436	398	422	433	[8]
59[8]	89[8]	144	64	73	11
256,377	248,501	227,749	229,780	229,533	164,355
17,254	18,213	20,722	22,628	17,083	16,928
21,357	21,653[3]	21,653[3]	18,003	19,177	[8]
188	192	185	220	[8]	[8]
102	155	169	191	248	[8]
674	644	626	655	689	[8]
23,194	26,826	28,664	32,187	30,333	24,113
1,968[3]	1,968[3]	1,984	1,807	1,513	2,346
239	362	349	474	689	[8]
492	549	448	455	517	513
10,008	10,383	8,819	9,166	10,244	10,169
9,814	10,237	10,949	10,567	12,968	12,867
109	98[3]	98[3]	[8]	[8]	[8]
737	819	820	934	1,078	[8]
2,257	2,068	2,034	1,848	1,844	[8]
1,265,000	1,329,000	1,312,000	1,150,000	1,296,000	1,100,000

[6] Saar production excluded in 1920 and 1921.

[7] Less than 1,000 tons.

[8] Included with German, Austrian and Russian production. 1913 output of territory now Polish (not including Upper Silesia) was 9,022,000 tons.

[9] Not including that part of Upper Silesia assigned to Poland in the autumn of 1921.

[10] Serbia only; total production in territory now included in Jugoslavia was, in 1913, 3,551,000 tons.

tion and converted the shortage into a surplus. As a result of world-wide industrial depression, the production of coal suffered still further curtailment. The output of 1921 is estimated at no more than 1,100 million tons, the smallest production of any year since 1909. The situation is indicated by Table D, which contains production data as far as available for the leading coal-producing countries for the period from 1913 to 1921.

The countries listed in Table D, it may be noted, fall into two groups, as respects the influence of the war on coal output. One group is comprised of those countries in which the war, by destruction of mines, drains on man power and general economic disorganization, forced a serious curtailment of production. It includes the European belligerents (with the exception of Italy) and such non-European countries as Canada and Australia. Of this group Belgium and Canada were the only important producers which had by 1920 succeeded in restoring their coal production to the pre-war level.

The other group comprises countries in which the scarcity and high price of coal stimulated an expansion of output, in some cases at least beyond the point of profitable operation under more normal conditions. In this group are the European neutrals, Italy, and the majority of non-European producing countries, such as Japan, China, India, South Africa and the United States. As a net result, the European production for 1920—the second year after the war and a period of urgent demand for coal—was approximately 125 million tons below the 1913 output. The production of the rest of the world for 1920 exceeded its pre-war output by about 100 million tons; a net reduction in production of 25 million tons.

Three countries, it will be noted from Table D, hold a strikingly dominant position in coal production. These are the United States, with over 44 per cent. of world output in 1920, the United Kingdom, with 18 per cent. and Germany with 19 per cent. of the aggregate. The next country in rank is France, which produces less than 3 per cent. of the world's total.

COAL PRODUCTION IN THE UNITED STATES

The United States, with its unrivaled coal resources and tremendous industrial demand, assumed first place among coal-producing nations about the beginning of the twentieth century. Since then, its output has more than doubled.

The mining of the two kinds of coal produced in the United States, anthracite and bituminous, constitutes two fairly distinct industries. Production of anthracite, which comprises, on the average, only 15 per cent. of the total output, is practically confined to a region in eastern Pennsylvania having an extent of about 480 square miles. Mining is largely centralized in the hands of a few producers, and production has become fairly stable, fluctuating between 79 million and 89 million tons in the period since 1913. The market for anthracite is also relatively stable. About 55 per cent. of the output is normally used for domestic consumption, 22 per cent. is employed in industry and the heating of large buildings, 7 per cent. is taken by railroads, 5 per cent. is exported and the balance is consumed at the mines. Consumption of anthracite is centered in the northeastern part of the country. Aside from anthracite consumed by railroads, two-thirds of the output is used in the Middle Atlantic States; New England receives 15 per cent., the North Central States

15 per cent., while the South and West take only 3 per cent. The limited extent of anthracite reserves and the increasing depths to which workings must be carried restrict output and prevent its becoming a more important factor in the coal situation.

Bituminous coal constitutes the bulk of the American output. It is mined commercially in thirty-one states; most of it, however, is produced within a comparatively limited area in the eastern part of the country. Over 65 per cent. of the total 1920 output was mined in the Appalachian region, extending from Pennsylvania to Alabama, a result in part of the quality and abundance of the coal, and in part of the concentrated industrial demand of the northeastern section of the United States. Table E indicates the current output of those states which in 1920[1] produced one or more per cent. of the total bituminous output. It also affords a comparison of their

TABLE E—PRODUCTION OF BITUMINOUS COAL BY STATES

State	1909-13 (5 yr.-aver.)	1920	1921
	(in thousands of gross tons)		
Pennsylvania	137,267	150,074	100,000
West Virginia	55,616	79,867	63,571
Illinois	48,569	79,135	60,268
Ohio	29,221	40,208	28,571
Indiana	14,264	25,974	16,964
Alabama	14,038	14,411	10,893
Kentucky	13,478	31,722	26,786
Colorado	9,475	10,959	8,152
Iowa	6,756	6,942	4,464
Wyoming	6,327	8,592	6,652
Virginia	6,214	10,039	6,964
Tennessee	5,945	5,880	3,929
Kansas	5,763	5,213	3,214
Utah	2,423	5,362	3,571
Other states	25,249	28,739	19,394
Total	380,605	503,117	363,393

[1]Comparisons are made on the basis of 1920 figures, because that year was one of active demand for coal, while 1921 was a year of serious depression.

current output with pre-war average production. Pennsylvania, it will be noted, is by far the leading producer, but its output is not now increasing at a rapid rate, the 1920 output being only 9 per cent. above its pre-war average. Illinois' production in 1920 was no less than 63 per cent. in excess of its pre-war average. Among other important producing states, Indiana increased its output 82 per cent., Ohio 38 per cent., and West Virginia 44 per cent., while Kentucky's 1920 production was 135 per cent. greater than its pre-war average.

DOMESTIC COAL TRADE OF THE UNITED STATES

Detailed information as to coal consumption in the United States is not currently available. The United States Fuel Administration, however, compiled information covering the several classes of consumption for the year 1917, and these data, presented in Table F, may be taken as indicating approximately the normal distribution of coal to different groups of consumers. The predominance of industrial and railroad requirements is noteworthy; the export trade on the contrary is relatively insignificant.

TABLE F—CONSUMPTION OF COAL IN THE UNITED STATES BY CLASSES

Class of use	Consumption in 1917 (in thousands of gross tons)	Per cent. of total
Industrial plants	155,900	32
Railroads	137,200	28
Coke, beehive and byproduct	74,800	15
Domestic consumers	51,000	10
Gas and electric public utilities	32,700	7
Exports	20,400	4
Power and heat at coal mines	10,800	2
Bunker, foreign	6,000	1
Bunker, domestic, including Great Lakes	3,200	1
Total	492,000	100

The distribution of bituminous coal from the different fields to various markets in the United States is highly complex. It is determined in part by the character of the coal and its suitability for particular requirements, and in very large part by the competitive position of other fields and by freight rates. The latter, because of the bulk of coal in proportion to its value, are of decided importance in influencing its markets. Much of the coal in the interior field is of inferior quality, and the competition of better-grade Appalachian coals confines it to local markets where it has a considerable advantage in cost of transportation. In the west the coal of the Rocky Mountain fields supplies local needs and in good part the requirements of the Pacific States also. In the southwest coal faces the competition of oil, which for many purposes is the dominant fuel.

The Appalachian fields extend from Pennsylvania to Alabama. Coal produced in the southern part of these fields, including Alabama, Georgia, Tennessee and southeastern Kentucky, is largely consumed by railroads serving the region and by the iron and steel industries centering about Birmingham. Certain of the coals of southeastern Kentucky, however, enjoy a wide market by reason of their quality, and are shipped in good volume north of the Ohio and to lake ports and west of the Mississippi.

Coals from the middle and northern portions of the Appalachian fields are predominant from the point of view of both quantity and quality. These coals furnish the bulk of coke produced, afford power for the concentrated industrial activities of the northern and eastern part of the country, move in large volume to the interior of the United States, constitute the bulk of shipments to Canada

and provide most of the ocean-borne exports from the country.

Rapid as has been the increase in consumption of coal in the United States, the area under exploitation and the mechanical equipment available—the productive capacity of the mines—have far outrun the growth of demand. The maximum actual production of bituminous coal was 518 million tons in 1918. The physical capacity of the mines has been estimated at from 600 million to 800 million gross tons per annum. This overdevelopment occasions a serious wastage of the capital and labor engaged in the industry. The average loss of time in the last thirty years has approximated 30 per cent., and even in 1918, the year of maximum activity, over 20 per cent. of the full working time was lost.

In some measure this situation is due to daily fluctuations in output which, particularly at times of active demand, are occasioned by car-shortage. In good part it is due to the decided seasonal fluctuation, as between summer and winter, in the demand for coal, and to the impracticability of storing it at the mines in any sufficient quantity. The resulting fluctuations in the production of coal are shown in Table G. The average monthly output for the period 1913–1920 is used as a basis, from which are computed the percentages which the average output by months constitutes of this base.

Beyond variations due to these causes, coal production is highly sensitive to changes in demand which are occasioned by the cycles of business activity and depression. The bulk of coal is sold on contract, and the concentration of a growing demand on the relatively limited volume of "free" coal often produces a substantial and sometimes a

spectacular rise in spot prices. This instability in price is in good measure the cause of the overdevelopment of American mining capacity. The reserves of coal, and the ownership of reserves, are so extensive that a period of comparatively high prices encourages the development of many new mines. After increased production or slackened demand has caused a lowering of prices, there are

TABLE G—SEASONAL FLUCTUATIONS IN COAL PRODUCTION IN THE UNITED STATES

	Quantity (in thousands of gross tons)	Per cent. of base
Base = Average Monthly Production 1913–20....	37,129	100
Average Production 1913–20 for—		
January..........................	38,686	104
February..........................	33,919	91
March..........................	37,405	101
April..........................	31,180	84
May..........................	34,550	93
June..........................	35,787	96
July..........................	37,479	101
August..........................	39,562	107
September..........................	39,773	107
October..........................	42,621	115
November..........................	36,609	99
December..........................	37,974	102

strong incentives to continue operations in order that carrying charges on the investment already made may be earned. Similarly, many concerns which for speculative purposes or to anticipate competition have acquired extensive holdings of coal land, are compelled to develop the properties and open mines in order to meet charges on the investment. The result of these factors is an increase of idleness in times of slack demand, and a dilution of car-supply and consequent enforced idleness when demand is active, that constitute a serious loss to the industry and to the country as a whole.

The course of coal prices in the United States for the period since 1913 is shown in Table H. Prices are quoted for anthracite stove coal, of importance as a domestic fuel, and for bituminous, Pittsburgh mine run, as representative of industrial fuel.

TABLE H—WHOLESALE PRICES OF COAL IN THE UNITED STATES, BY QUARTERS, 1913 TO 1921[1]

Year	Bituminous—Pittsburgh District run of mine, f. o. b. mine (in dollars per net ton)				Anthracite—Stove f. o. b. mine (in dollars per gross ton)			
	January	April	July	October	January	April	July	October
1913	1.30	1.30	1.35	1.40	4.00	3.50	3.80	4.00
1914	1.30	1.30	1.30	1.30	4.00	3.50	3.80	4.00
1915	1.15	1.05	1.00	1.05	4.00	3.50	3.80	4.00
1916	1.25	1.05	1.30	3.25	4.10	3.60	4.20	4.40
1917	4.25	3.25	3.00	2.00	4.40	3.90	4.20	4.70
1918	2.45	2.45	2.35	2.35	5.05	4.75	4.75	5.05
1919	2.35	2.25	2.25	2.35	6.10	6.10	6.40	6.60
1920	2.35	4.25	10.00	9.00	6.60	6.60	7.65	8.00
1921	2.75	2.75	2.50	2.25	8.00	7.40	7.90	8.50

[1] Prices are for available dates nearest 15th of months specified.

THE INTERNATIONAL COAL TRADE

The number of countries which produce a net surplus of coal above their domestic requirements, which may be used to meet the fuel needs of less favoured nations, is extremely small. In the Western Hemisphere, the United States alone has a surplus of coal for export; and this, while it is large in comparison with the surpluses of most other nations, is of small proportions when compared with the tremendous domestic consumption of coal. The total output of South American countries in 1913 was less than 1,600,000 tons or about one-sixth of their consumption.

In Asia, Japan normally has a surplus of approximately three million tons which is exported to Shanghai, Hongkong, the Philippines and Singapore. China's output is

no more than sufficient to meet its own requirements. The bulk of Indian production is required by the railroads and growing industries of the country. Indo-China produces approximately 650,000 tons of anthracite of which more than half is exported.

Australia normally produces a surplus. New Zealand on the contrary has to import coal from the former country. Australian coal is extensively used in bunkering in the Pacific, and is also shipped to the Dutch East Indies, Singapore, Colombo, the west coast of South America and in small amounts even to the west coast of the United States. The South African mines support a growing export trade and some of their coals which are of good steaming quality are in demand for bunkerage at South African and Indian ports.

In Europe, Great Britain and Germany are the only countries which are in a position to export coal in quantity. Other countries must import. Great Britain and Germany are the dominating factors, the former in the ocean-borne trade, the latter in the land trade of Europe.

BRITISH COAL TRADE

Coal is Great Britain's most important natural resource, and has been utilized to make that nation the world's greatest exporter of coal, both in the form of coal for bunkerage, and exports in the strict sense. Table I affords a comparison of the pre-war and post-war exports from Great Britain.

It will be noted that British exports to all countries have been reduced, in many cases most substantially, and the total for 1921 amounted to only 36 million tons, against 85 million for the pre-war average. This is a consequence

of the decline of British production, which in 1913 was 287 million gross tons and in 1920 only 230 million tons. In 1921, a prolonged miners' strike reduced the output for the first six months to 55 million tons, the output for the

TABLE I—EXPORTS OF COAL FROM THE UNITED KINGDOM

Country	1909–13 (5-yr. aver.)	1919	1920	1921
	(in thousands of gross tons)			
Countries around the North Sea—				
Belgium	1,707	144	671	618
Denmark	2,848	1,743	1,040	1,804
Germany	8,999	...	13	818
Netherlands	2,162	402	239	1,788
Norway	2,069	1,331	801	694
Russia and Finland	4,008	221	93	139
Sweden	4,094	1,592	1,372	1,233
Remainder of Europe, and Egypt—				
Egypt	2,873	1,675	985	1,018
France	10,647	16,205	11,691	6,396
Greece	604	139	98	249
Italy	9,183	4,641	2,905	3,383
Portugal	1,024	544	301	436
Spain	2,190	806	290	1,021
South America—				
Argentina	3,129	639	274	887
Brazil	1,604	189	158	242
Chile	690	7	7	23
Uruguay	895	185	117	222
Countries not specified above	6,795	4,787	3,877	3,690
Total	65,521	35,250	24,932	24,661
Bunker, vessels in foreign trade	19,565	12,021	13,840	10,926
Grand total	85,086	47,271	38,772	35,587

year being 164 million tons. Despite this handicap and the general depression in the international coal trade, British exports to other countries in 1921 were approximately equal to exports in the preceding year.

Should the curtailment of British coal exports prove permanent it would have no small influence on the future of the country's foreign trade. Upon ability to export

coal depends Great Britain's ability in large measure to import the raw materials necessary for the carrying on of her great industrial life.

British exports, other than coal, are chiefly in the form of light manufactured goods. To produce these goods and to support a dense industrial population, it is necessary to import bulky raw materials and foodstuffs. Coal is the export ballast that makes British import trade possible. Its use in balancing incoming and outgoing cargoes is of great effect in reducing the cost of ocean transportation, for example, on such commodities as grain from Argentina and iron ore from Brazil. Conversely, the curtailment of the surplus of coal for export has been felt in inability to secure ore supplies from overseas when desired, because it was not possible to provide inward ore ships with outward freights of coal.

The decrease in production has occurred in spite of an increase in the number of miners employed, and the decline in output per man is a matter of serious concern to the British public. Output of coal per man in Great Britain, which was practically stationary during the four years preceding the war, and actually increased during 1915, has sharply declined since 1916, although tending to improve in 1922. In this, British experience is in marked contrast with that in the United States, where, with occasional recessions, output per man has been increasing steadily for a considerable period. Table J compares the two countries in this respect for the period from 1910 to 1920.

There has been wide divergence of opinion as to where responsibility for declining British production and low output per man rests. In part it is due to partial exhaus-

tion of mines and increasing depths to which workings must be carried. Shortage of underground equipment and railway cars has been a factor. Serious labor difficulties have accounted for much of the curtailment. A con-

TABLE J—AVERAGE COAL OUTPUT PER MAN, GREAT BRITAIN AND UNITED STATES

Year	Great Britain (in gross tons)	United States (in gross tons)
1910	252	618
1911	255	614
1912	239	660
1913	258	681
1914	234	601
1915	265	647
1916	256	731
1917	243	768
1918	225	794
1919	193	713
1920	182	743

siderable factor is the relatively small use of machine mining in Great Britain. For the five years 1909–1913 machine-mined coal averaged but 7 per cent. of total British production, as compared with 37 per cent. for the same period in the United States. Since then machine mining has increased somewhat, particularly in the Scottish mines where about one-quarter of the coal is now machine-mined. In the Welsh coal fields, however, only 2 per cent. of the output is reported as machine mined. The slow progress of machine production in Great Britain is a result partly of hostility on the part of miners, who fear that its adoption would cause a dearth of work for many men now employed at the mines. In part it is a result of the fact that many British mines are physically ill-suited to machine methods.

It may be questioned whether, in the pre-war period,

Great Britain had not reached the zenith of its position as a coal-exporting nation. Production was increasing only slowly—in the period from 1907 to 1912 it fluctuated within the narrow range of 260 million to 272 million tons. Domestic requirements were growing and will in the future absorb a larger proportion of output, with the normal development of British industry. During the years 1907 to 1912 exports of coal were practically constant at from 62 million to 65 million tons. While in 1913 exports were substantially larger, the increase represented an abnormal rather than a normal development. As the coal requirements of other nations expand, therefore, it is probable that they will have to be met from other sources, and that the future position of the United Kingdom in the international coal trade will gradually become relatively less dominant than it has been in the past.

THE GERMAN POSITION

Prior to the war Germany dominated the land coal trade of Europe. Its production had been growing steadily and with great rapidity, having more than tripled in the period from 1890 to 1913. Of the total 1913 output of 273 million tons, 187 million tons were bituminous coal and 86 million tons were lignite, much of which must be briquetted before it can be used. Lignite plays an unimportant part in Germany's foreign coal trade but forms an increasingly important element in domestic consumption, a development which was hastened by Germany's isolation during the war.

The volume and direction of pre-war exports of German coal and coke are indicated in Table K. Austria was the principal market for raw coal, while the Netherlands,

Belgium, France, Switzerland and Russia also took substantial quantities, ranking in the order named. The iron works of French Lorraine were by far the most important foreign takers of German coke. Austria, Belgium and Russian Poland also received considerable amounts.

TABLE K—AVERAGE ANNUAL EXPORTS OF COAL AND COKE OF DOMESTIC PRODUCTION FROM GERMANY, 1909 TO 1913

Country	Coal (in thousands of gross tons)	Coke (in thousands of gross tons)
Austria-Hungary	10,128	867
Belgium	4,685	539
Denmark	170	42
France	2,617	1,878
Italy	550	136
Netherlands	5,933	239
Norway	24	36
Russia and Finland	1,338	358
Sweden	70	138
Switzerland	1,414	150
Other countries	530	422
Total	27,459	4,805
Bunker, foreign vessels	247	1
Grand total	27,706	4,806

While in 1913 Germany exported more than 44 million gross tons of coal or its equivalent in coke and briquettes, it imported somewhat more than 18 million tons. This interchange is an illustration of the influence of freight rates on coal distribution, irrespective of political boundaries. The greater part of the import consisted of British coal marketed in the Baltic provinces, where, by reason of lower transportation costs, it could be sold more cheaply than coal from the Ruhr fields in Germany.

Germany's position with respect to coal for the period from 1913 to 1920 is summarized in Table L. It will be noted that the practical elimination of imports during the war years was more than counterbalanced by a reduction of

exports from 44,202,000 tons in 1913 to 13,828,000 in 1918. Even so, there was some curtailment in domestic supplies of coal which was, however, in a measure offset by the growth in output of lignite, from 85,855,000 tons in 1913 to 99,010,000 tons in 1918. The further curtailment of domestic consumption of bituminous coal in 1919 and 1920 reflected in part the decreased output of those years, as well as compulsory reparations deliveries of coal to the allied nations.

TABLE L—GERMAN COAL SITUATION, 1913 TO 1920

Year	Bituminous Coal: Production	Imports	Exports[1]	Available for consumption	Lignite production[2]
	(in thousands of gross tons)				
1913.....	187,107	11,145	44,202	154,050	85,855
1914.....	158,836	6,846	33,424	132,258	82,372
1915.....	144,548	2,616	22,373	124,791	86,559
1916.....	156,656	1,381	20,615	137,422	92,693
1917.....	165,098	575	18,658	147,015	94,034
1918.....	155,755	141	13,828	142,068	99,010
1919.....	114,864	48	8,431	106,481	92,167
1920.....	129,273	328	22,265	107,336	109,871

[1]Including reparations deliveries in 1919 and 1920.
[2]Consumed almost entirely in Germany.

The Peace has affected the German coal position profoundly, as regards both production and domestic requirements. Major territorial changes from the point of view of the coal situation were the cession to France of Alsace-Lorraine permanently and of the Saar mine fields for a period of fifteen years. Upper Silesia, the status of which was not determined until the latter part of 1921, has been divided between Germany and Poland, the latter receiving the bulk of the coal reserves. The effect of territorial changes on the German coal position is summarized in Table M, which compares the pre-war production and

consumption of territories now German, as well as of the districts which are now separated from Germany.

TABLE M—COMPARISON OF GERMAN PRODUCTION AND CONSUMPTION OF COAL[1] IN 1913, BY DISTRICTS

District	Production in 1913	Consumption in 1913
	(in millions of gross tons)	
Territory remaining definitely German	126	114
Upper Silesia		
Region allotted to Germany	11	[2]
Region allotted to Poland	32	[2]
Total	43	14
Alsace-Lorraine	6	11
Saar Basin	12	6
Other ceded territory	..	5
Luxemburg[3]	..	4
Total	18	26
Grand total	187	154

[1]Not including lignite, the bulk of which is produced and consumed in territory still German.

[2]Not available.

[3]Formerly included in the German Customs Union.

It will be observed that apart from Upper Silesia the territory definitely ceded by Germany consumed considerably more coal than it produced—a result very largely of the heavy requirements of the iron and steel industries in Alsace-Lorraine. The situation with respect to Upper Silesia is different. That region produced a very substantial volume above its local requirements, the loss of which may seriously curtail Germany's ability to export coal.

Beyond such territorial changes, the treaty of peace made elaborate provisions for deliveries of coal[1] to allied countries. By its terms Germany undertook to deliver

[1]Data respecting Treaty requirements are given in metric tons, which may, however, be taken as the practical equivalent of the gross ton, used elsewhere throughout the article.

to France 7,000,000 tons of coal per year for ten years, and in addition, for a period not exceeding ten years, an amount of coal equal to the difference between the annual pre-war production of the mines in the devastated regions of France and the production of those mines during each year of the ten-year period. Such delivery was not to exceed 20,000,000 tons per year in any one of the first five years, and 8,000,000 tons in any year of the succeeding five years. In addition, Germany agreed to deliver to Belgium 8,000,000 tons of coal per year for ten years, and to Italy an annual amount beginning at 4,500,000 tons for the year ending June, 1920, and gradually increasing to 8,500,000 tons per year for each of the six years 1923 to 1929. Germany further undertook to deliver annually to Luxemburg, if so directed by the Reparation Commission, an amount of coal equal to the pre-war annual consumption of German coal in Luxemburg.

Germany found it impossible to meet the payments called for by the treaty, her total deliveries from August, 1919, to the end of May, 1920, aggregating only 5,100,000 tons. This unsatisfactory situation led to the Spa conference, which resulted in the temporary suspension of treaty requirements. Germany in return agreed to place at the disposal of the allies for six months from August 1, 1920, coal at the rate of 2,000,000 tons per month of which France was to receive 1,500,000 tons, Belgium 215,000 tons, Italy 200,000 tons and Luxemburg 35,000 tons. These deliveries have been made by Germany, total deliveries in 1920 approximating 17 million tons of coal or its equivalent in coke. Since the termination of the period covered by the Spa agreement, the quantities to be delivered have been fixed periodically by the Reparation

Commission, the monthly quotas in the latter half of 1921 averaging about 1,700,000 tons and at the beginning of 1922, about 1,900,000 tons.

Wholly apart from the reduction in output caused by the loss of territory, there was a marked falling off in coal production, occasioned largely by disorganization incident to the war and the revolution. Output of the Ruhr district, by far the major German producing region, dropped from 113 million tons in 1913 to 70 million tons in 1919, rising to 90 million in 1921. Upper Silesian output dropped from 43 million tons in 1913 to less than 26 million in 1919, and totaled 29 million in 1921. For all regions now German, and including Upper Silesia, output in 1913 was approximately 170 million tons; in 1919, 106 million tons and in 1921, 134 million tons. Lignite production made a steady growth from 86 million tons in 1913 to 121 million tons in 1921. While the reduced coal output has occasioned severe coal shortages in Germany and accounts for the difficulty had in making deliveries called for by the treaty, the gradual restoration of German output will place Germany in a fairly satisfactory position. Deliveries to the allied nations are essentially of the nature of exports. The loss of a considerable proportion of the Silesian output is a serious handicap, but it will not endanger Germany's industrial future, since much of the Silesian output is consumed in the Silesian and Polish iron and steel industries, while Germany's iron and steel industry is dependent on and is located in close proximity to the Ruhr coal fields in the western part of the country.

Of the new countries of Europe, Poland and Czechoslovakia alone possess important coal reserves. Poland

has benefited substantially by the Upper Silesian partition, and in the future, with the restoration of normal output from Polish and Silesian mines, it may become a considerable exporter of coal. Prior to the war, the normal output of mines in territory now Polish (exclusive of Upper Silesia) was about 9,000,000 gross tons, while consumption approximated 19,000,000 gross tons, the balance being met by imports, chiefly from Upper Silesia. The pre-war output of the section of Upper Silesia allotted to Poland was over 32,000,000 tons. Under normal conditions of output, therefore, Poland should have available a total supply of 41,000,000 tons against total domestic requirements of about 30,000,000 tons. The acquisition of Silesian mines, moreover, assures the Polish iron and steel industry a supply of coking coal not available from domestic mines.

The territory now included in Czechoslovakia had a pre-war output of about 37 million tons of which 14 millions were coal and 23 millions were lignite. Its output of coal was below domestic requirements, while it was an exporter of lignite. Its 1921 output was 32 million tons, of which 21 millions were lignite.

COAL IMPORTING COUNTRIES OF EUROPE

Average pre-war consumption of coal in France, the major importing country of Europe, was estimated at about 61,000,000 gross tons, production being about 40,000,000 tons. The remaining 21,000,000 tons were imported, principally from Great Britain. In 1913 France's actual imports were 18,416,000 tons, of which 11,079,000 were from Great Britain, 3,611,000 from Belgium, and 3,436,000 from Germany.

The largest coal mines of France are located in the Valenciennes Basin, in the Departments of Nord and Pas de Calais. About these mines, which had a pre-war output of more than one-half of the total French production, was centered the iron and steel industry of France. These mines were destroyed during the war and it is estimated that their restoration to their former level of production will hardly be effected before 1926. Their output in 1913 was 18,367,000 tons; in 1919, 1,516,000 tons and in 1921, 5,280,000 tons. While, by the terms of the Peace Treaty, France has received Alsace-Lorraine and the Saar, with a combined production for 1913 of more than 17,000,000 tons, the consumption of these districts almost equaled that figure. Saar output, moreover, declined from 12,030,000 tons in 1913 to 8,839,000 tons in 1919 and 9,669,000 tons in 1921.

These various factors have substantially increased the relative volume of coal in comparison with total requirements which France must import. Exclusive of receipts from the Saar, total French imports of coal for 1920 were approximately 22 million gross tons, of which 12 million came from Great Britain, 5 million from Germany and 3 million from the United States. In addition France imported 4 million tons of coke, the bulk of which came from Germany, and 2 million tons of fuel briquettes, from Germany, Belgium and Great Britain. In 1921, French imports included 16 million tons of coal, 3 million of coke, and one of briquettes; the bulk of imports coming from Germany, Great Britain and Belgium, in the order named.

Belgium, in 1913, consumed about 26 million tons of coal and produced 22 million tons. It is both an export-

ing and an importing country, shipping coal to France, Italy and Luxemburg, and importing it from Germany and, to a less extent, from Great Britain. For 1920, its imports totaled 2,244,000 tons while its exports aggregated 2,166,000 tons, including coke in equivalent terms of coal. In 1921, imports totaled 6,238,000 tons and exports 7,788,000 tons.

The Netherlands' pre-war production was about one-fifth of its requirements of approximately 10 million tons, the balance of which was supplied by Germany and the United Kingdom. The difficulty experienced in getting coal during the war led to the development of domestic resources by which production was raised from two million tons in 1913 to four million in 1920. Substantial quantities of coal were also imported from the United States in meeting the shortage. For 1920 total imports of coal (including coke in terms of coal) aggregated 3,417,000 tons, and for 1921, 5,317,000 tons.

The Scandinavian countries, aside from approximately 400,000 tons produced in Sweden, rely on outside sources for their coal. Normally the bulk of it is gotten from Great Britain in return for iron ore and timber. The Scandinavian countries have also been importers of American coal in meeting the abnormal shortage of recent years. Thus, in 1920, American coal constituted 44 per cent. of Swedish imports. The Mediterranean countries—Spain, Italy, Greece, Egypt and Northern Africa—normally depend on British coal but have become purchasers of American coal during and since the war. Spain is the only one of the group which produces a substantial proportion of its own requirements.

THE UNITED STATES IN RELATION TO THE INTERNATIONAL COAL TRADE

For the five years 1910–14, the average coal output of the United States, including anthracite, was 467,128,000 tons. For the five years ending June 30, 1914, the net exports, including bunker coal, averaged less than 23,000,000 tons and of this amount, exports to Canada, which were not essentially different from the domestic trade, accounted for 13,500,000 tons.

These figures indicate the relative unimportance of the pre-war coal exports of the United States as compared with its domestic coal trade. The development of the American export trade during and since the war is summarized in Table N. From a pre-war average of 22,782,000 tons, exports including bunker coal gradually increased to 32,232,000 tons in 1917, then after falling off during 1918 and 1919, jumped to 47,450,000 tons in 1920, and declined to 31,248,000 tons in 1921. The bulk of the increase reflected substantial takings by the countries of Europe

TABLE N—NET EXPORTS (TOTAL EXPORTS LESS IMPORTS) OF COAL FROM THE UNITED STATES, 1910 TO 1921[1]

Year	Bituminous Exports	Bituminous Bunker, vessels in foreign trade	Anthracite	Total
	(in thousands of gross tons)			
1910–14 (5-yr. aver.)...	12,234	7,020	3,528	22,782
1915..................	15,245	7,471	3,537	26,253
1916..................	17,471	7,826	4,160	29,457
1917..................	19,997	6,883	5,352	32,232
1918..................	18,656	5,532	4,402	28,590
1919..................	17,057	7,343	4,369	28,769
1920..................	33,292	9,362	4,796	47,450
1921..................	19,532	7,548	4,168	31,248

[1]Average relates to fiscal years ending June 30; other years are calendar years. Period from June 30, 1914, to January 1, 1915, omitted.

resulting from the disorganization of their normal sources of supply. Other countries, also, notably those in South America, increased their imports of American coal as British supplies were curtailed.

The direction of exports from the United States, as well as the striking increase of the movement of American coal to European and other coal-importing countries in post-war years, is shown in detail in Table O. It may be noted that, substantial as was the increase in the volume of exports in 1920 as compared with the pre-war period, exports still constituted a relatively small proportion of the total American production. At the same time, when foreign demand is concentrated principally on the relatively small volume of "free" (as contrasted with contract) coal, as was the case in 1920, it may occasion a rise in prices, and so have an influence on the entire domestic situation out of all proportion to its quantitative importance.

In view of the over-development of American mining capacity, outlined in the discussion of the American domestic coal trade, the question arises as to the future position of the United States in the international coal trade, and the possible utilization of surplus capacity in putting coal into foreign markets.

It is generally recognized that the bulk of the increase in American exports during recent years is of an emergency character, representing purchases in the United States because coal could not be had elsewhere.

There are a number of factors which make it difficult to put American coal into European markets permanently. Only the best smokeless coals of the Appalachian region meet export requirements. These coals must be trans-

TABLE O—EXPORTS OF COAL FROM THE UNITED STATES BY COUNTRIES, 1910 TO 1921[1]

	1910-14 (5 yr. aver.)	1918	1919	1920	1921
		(in thousands of gross tons)			
Bituminous:					
Countries around the North Sea—					
Belgium	[2]	...	[2]	275	24
Denmark	...	...	89	967	153
Netherlands	1	17	722	2,147	334
Norway	1	...	160	736	42
Sweden	...	...	253	1,247	67
Remainder of Europe, and Egypt—					
Egypt	58	...	38	627	476
France	50	7	523	3,646	608
Greece	...	3	48	231	96
Italy	357	10	1,633	2,388	1,549
Portugal	2	5	45	164	100
Spain	23	...	19	66	58
Switzerland	...	...	529	812	9
South America—					
Argentina	78	179	483	1,718	753
Brazil	185	559	634	965	527
Chile	58	300	94	494	151
Uruguay	21	229	195	268	88
North America—					
Canada	10,002	16,191	10,669	14,483	11,961
Cuba	1,051	1,440	971	1,333	525
Mexico	469	163	102	203	172
Countries not specified above	1,394	853	752	1,620	2,960
Total	13,750	19,956	17,959	34,390	20,653
Bunker, vessels in foreign trade	7,020	5,532	7,343	9,362	7,548
Total bituminous	20,770	25,488	25,302	43,752	28,201
Anthracite:					
Canada	3,470	4,379	4,345	4,436	4,035
Other countries	63	57	98	389	141
Total anthracite	3,533	4,436	4,443	4,825	4,176
Grand total	24,303	29,924	29,745	48,577	32,377

[1]Average relates to fiscal years ending June 30; other years are calendar years.
[2]Less than 1,000 tons.

ported by rail for 200 miles or more before they reach tidewater. British export coals are within 15 miles of the sea. After reaching tidewater, American coals have to bear ocean transportation charges across the Atlantic, while the United Kingdom and Germany are adjacent to the principal European markets. Moreover, the balance of ocean freights between America and Europe is decidedly against the United States. This country imports manufactured goods from Europe, and exports bulky raw materials, such as cotton and grain, and heavy iron and steel products. Great Britain, on the other hand, imports bulk commodities and utilizes coal as outward ballast. The same in less degree is true of Germany. These factors made it impracticable to market American coal in Europe in substantial quantities prior to the war, and they will become increasingly effective as normal conditions of coal production are restored in Europe.

The situation is somewhat different with respect to Central and South American countries. There, the physical balance of freights is more favorable to the United States. The same is true of the distance which the coal must be shipped, particularly as respects the countries in the Caribbean and on the west coast of South America. Prior to the war the bulk of American seaborne coal exports went to the Caribbean region, and this trade did not differ essentially from the local coastwise shipments in the domestic coal trade.

While the United States is in a position to compete for the South American coal trade on a permanent basis, that trade cannot comprise any considerable volume. The tropical climate of much of the country, its small popula-

tion, and the limited extent of industrial development make the present South American requirements small.

The conclusion seems inevitable that, apart from the provision of fuel to Canada, the foreign coal trade of the United States will not become of great importance. The United States is too far distant from the great coal-consuming markets. Probably its exports to Europe will continue permanently on a level considerably above the pre-war figure; nevertheless, they can hardly form more than a very small proportion either of Europe's requirements or of American production.

This is, on the whole, highly desirable. It is not economical to move so bulky a commodity as coal to support industries at distant points. The tendency is strongly in the direction of locating the industry where power is readily available. In Europe coal shortage has hastened and will continue to stimulate the development of water power. The industrial development of the United States has by no means reached its completion, and available resources are not at all excessive in comparison with future requirements. For this country, the export of coal in the shape of finished goods rather than in raw state constitutes the sounder industrial development.

COTTON

THE cotton trade is essentially international. Raw cotton forms the chief item both of American exports and British imports. Before the war, also, it was the principal article imported into Germany and Japan and was among the leading imports into France, Belgium, and other important industrial countries. Cotton manufactures, moreover, regularly are the principal export from the United Kingdom and the chief import into India, China, Turkey, the Dutch East Indies and many other countries having little industrial development.

In the years just before the war about 12,000,000 bales of raw cotton, or more than one-half of the total annual crop of 22,000,000 bales, were exported from the cotton-growing countries, thus enabling the countries of western Europe, Canada and Japan, although they did not grow any appreciable amount of cotton, to count cotton manufacturing among their chief manufacturing industries. In addition, out of a total world production of 36,000,000,000 yards the annual exports of cotton piece goods were 10,000,000,000 yards, while large quantities of yarn, thread, wearing apparel and other cotton manufactures also passed into international trade.

Exports of raw cotton were greatly curtailed after the war by unsettled conditions in Europe. Nevertheless, over 6,600,000 bales of raw cotton were exported from the

United States in 1921. This amount compares, however, with an annual average of nearly 9,000,000 bales in the period from 1909 to 1913.

The United Kingdom has long played a leading part in the world's cotton trade. Obtaining the raw material chiefly from the American surplus, the British manufacture cotton goods to an amount second only to the American output, and consume so little that before the war the United Kingdom exported 6,700,000,000 yards of piece goods as compared with only 400,000,000 yards exported by the United States, its nearest competitor. Imports of raw cotton into the United Kingdom in 1921 amounted to 2,300,000 bales, of which 1,600,000 came from the United States, whereas in the five years from 1909 to 1913 the imports averaged 4,500,000 bales a year, of which 3,400,000 were bought from the United States.

Though India and Egypt, the second and third largest cotton producers, are both British possessions, they together supplied only a little over a fifth of the needs of the United Kingdom both before the war and in 1921. The British, therefore, to assure themselves of adequate supplies, have been trying diligently to develop cotton-producing areas elsewhere among their possessions as well as to increase the yield and improve the quality of the crops in the regions already growing cotton within the Empire.

Cotton has been known to western Europe since Alexander the Great introduced it from India, but it did not become a leading textile manufacture there until about the middle of the eighteenth century. Prior to this the world relied upon the primitive methods copied from the Hindus and had, in fact, imported much of its cloth from

India. After the invention of the fly-shuttle and the spinning-jenny cotton rapidly replaced wool as the chief English textile. Cotton had been discovered growing in the West Indies and on the mainland of America by Columbus and his followers, and the British turned to the New World rather than to the Old for their supplies. It has been estimated that near the close of the eighteenth century the West Indies furnished about 70 per cent. of the British supply, the Mediterranean countries 20 per cent., and Brazil 8 per cent. The quantity contributed by the United States and India was less than 1 per cent. and Egypt furnished none.

PRINCIPAL PRODUCING COUNTRIES

Cotton production is limited to warm climates, where ample moisture is assured either by rainfall or irrigation, but where there is little danger of excessive rain or early frosts. Average pre-war crops of the chief cotton-growing countries, according to the best estimates available, together with estimates of the crops for each year from 1915 to 1921 are shown in Table A. Chinese production as indicated in the table refers to the amount of the spinning-mill consumption plus net exports, for although it is known that the crop greatly exceeds this amount there are no satisfactory data as to the total crop or the consumption of cotton in Chinese homes. The latest estimate of the Chinese Ministry of Agriculture was that in 1916 the crop amounted to 5,200,000 bales. Comparatively little of this cotton, however, became available to commerce.

There has been a considerable falling off in cotton production in recent years, but although the world crop in 1921 was approximately 15,000,000 bales as compared

with 22,000,000 before the war, the decline was largely offset by the stocks of raw cotton that had accumulated during the war.

In addition to the quantities shown in Table A the United States produced an average of 612,000 bales of linters from 1910 to 1914, and 441,000 bales in 1920, while in 1921 the output was 398,000. "Linters" is the term applied to the short fibers which adhere to the seed

TABLE A—COTTON PRODUCTION BY PRINCIPAL COUNTRIES

Country	1910-14 (5-yr. aver.)	1915	1916	1917	1918	1919	1920	1921
			(in thousands of 500-lb. bales)					
United States	14,259	11,192	11,450	11,302	12,041	11,421	13,440	7,954
British India	3,524	2,990	3,602	3,200	3,182	4,637	2,845	3,623
Egypt	1,513	989	1,049	1,304	999	1,155	1,251	684
Russia	1,023	1,465	1,065	578	550	420	80	50
China[1]	694	845	810	830	900	1,100	1,000	1,650
Brazil	346	250	309	400	524	536	430	560
Mexico	138	125	140	125	130	200	205	165
Persia	128	130	[2]	[2]	[2]	[2]	[2]	[2]
Turkey	119	100	[2]	[2]	[2]	[2]	[2]	[2]
Peru	104	93	108	110	114	165	150	146
Chosen	85	126	126	182	206	[2]	[2]	[2]
Uganda	21	20	20	19	18	28	42	65
Other countries	144	204	304	199	201	432	328	310
Total	22,098	18,529	18,983	18,249	18,865	20,094	19,771	15,207

[1]Commercial crop only.
[2]Not available.

of the American upland and Indian varieties of cotton after it has been through the gins. These fibers are removed from the seed as a step preliminary to crushing the seed. They are of comparatively small value, being used chiefly for stuffing mattresses, horse collars, etc. During the war this cotton was in great demand also for the manufacturing of guncotton.

The growth of cotton as a cultivated crop in the United States is first reported as in Virginia in 1621 and in South Carolina and Georgia over a century later. The first exports to England were recorded in 1739 but until Eli

Whitney invented the cotton-gin in 1793 more was imported than exported.

Production in the United States amounted to 3,138 bales of 500 pounds each in 1790, to 6,276 bales in 1792, to 10,460 in 1793, and to 16,736 in 1794. By 1835 it had grown to 1,000,000 bales; in 1879 it reached 5,000,000 bales; and in 1894, 10,000,000 bales. From about this time the American crop was hindered by the boll weevil which invaded the cotton belt from Mexico in 1890. Year by year this pest has extended its activities until now it has infested practically the entire belt and has done great damage to the crops. Nevertheless, the record crop of 16,135,000 bales was grown in 1914, when the weevil had infested nearly one-half of the cotton belt. Means for fighting the boll weevil have been developed, but they involve the use of more labor and materials than prior to the invasion.

Cotton was the third most valuable American crop in 1921, having an estimated total value, including the value of the seed, of $783,000,000 and ranking only after corn and hay. Texas, with its large acreage and favorable climate, is the leading cotton state. In 1921 it was estimated to have produced 2,200,000 bales or over a quarter of the total crop. Mississippi with a production of 870,000 bales, Arkansas with an 860,000-bale crop, Georgia with 840,000 bales, North Carolina with 800,000 bales, South Carolina with 760,000 bales, and Alabama with 635,000 bales were the other principal cotton-growing states.

VARIETIES OF COTTON

The relative quality of the various kinds of cotton grown in the different countries in 1920 is shown in Table B,

together with the approximate yield of each kind. The classification is based upon the length of staple, and ranges from Grade I, which has a staple of two inches or over, to Grade V, which has a staple of one inch or less. It

TABLE B—WORLD'S COTTON CROP IN 1920 ACCORDING TO GRADES

	Quality and grade	Length of staple (in inches)	Where grown	Crops (in thousands of 500-lb. bales)
I.	Best Sea Island	2 and over	West Indies	4
			Islands of South Carolina	(1)
			Total	*4*
II.	Best Egyptian (Sakel, etc.)	$1\frac{1}{2}$–$1\frac{3}{4}$	Egypt	550
	American-Egyptian		Arizona and California	92
	Sea Island		West Indies	2
			Florida and Georgia	1
			Total	*645*
III.	Egyptian	$1\frac{1}{4}$–$1\frac{1}{2}$	Egypt	701
	Peruvian		Peru	150
	Long Staple American		Mississippi Delta, etc.	112
			British East, Central and South Africa	46
			Sudan	18
			Total	*1,027*
IV.	American Upland, etc.	$\frac{3}{4}$–$1\frac{1}{4}$	United States	13,235
			Brazil	430
			India	235
			Mexico	205
			China and Chosen	200
			Turkey and Persia	87
			Russia	32
			British West Africa	13
			Total	*14,437*
V.	Indian, etc.	$\frac{3}{8}$–1	India	2,610
			China	1,000
			Russia	48
			Total	*3,658*
			Grand total	19,771

[1] Less than 1,000 bales.

will be noted that the bulk of the world's cotton falls within Grade IV, which has a staple of from $\frac{3}{4}$ of an inch to $1\frac{1}{4}$ inches.

Especial value is attached to long-staple cotton because

of its use in the manufacture of automobile tires, thread, and the higher grade fabrics. The best of this kind of cotton is that grown on the islands off Charleston, South Carolina, and also in the West Indies. Next come the Sea Island cotton grown in Florida and Georgia and the best Egyptian grades. As late as 1917 the United States produced 71,980 bales of Sea Island cotton. Unfortunately, as this cotton matures late, it is particularly vulnerable to the attacks of the boll weevil. In 1918 this pest had so penetrated into the territory where Sea Island is grown that the crop was reduced to 40,900 bales. In 1919 it had fallen to 5,020 bales and in 1920 to 1,440 bales.

A variety of long-staple upland cotton called Meade cotton closely resembles Sea Island but since it matures two or three weeks earlier it is not so liable to the ravages of the boll weevil. It was developed during 1912 and is reported as now established on a commercial basis.

Another long-staple variety of cotton grown in the United States is the American-Egyptian cotton grown on irrigated land in Arizona and southern California. In 1912 the seed of this cotton was distributed to a number of farmers by the United States Department of Agriculture. The crop amounted to 375 bales of 500 pounds each. By 1917 the crop had grown to 15,966 bales, in 1918 to 40,343 bales, in 1919 to 42,374 bales, and in 1920 to 91,965 bales, but in 1921 this crop was reduced to less than 40,000 bales.

The bulk of the American long-staple cotton is of the upland variety and is grown chiefly in the Mississippi Delta, Arkansas, Texas, Oklahoma, and South Carolina. In 1920 the upland crop having a staple of over 1¼ inches

amounted to 112,000 bales, while 1,112,000 bales had a staple of from $1\frac{1}{8}$ to $1\frac{1}{4}$ inches.

Of the total cotton crop in the United States in 1920, however, 12,123,000 bales or 90 per cent. had a staple of less than $1\frac{1}{8}$ inches.

PRINCIPAL EXPORTING COUNTRIES

Exports of cotton are naturally made chiefly by the leading cotton-growing countries. Table C shows the net exports, that is, the total exports minus the total imports, of cotton from the principal exporting countries in the five years from 1909 to 1913, in 1919, 1920 and 1921.

TABLE C—NET EXPORTS OF COTTON FROM THE PRINCIPAL EXPORTING COUNTRIES

Country	1909–13 (5-yr. aver.)	1919	1920	1921
	(in thousands of 500-lb. bales)			
United States	[1]8,622	[2]6,365	[2]5,734	[2]6,322
British India	1,820	1,443	1,937	2,010
Egypt	1,382	1,329	793	949
China	188	222	[3]	[4]
Persia	104	[4]	[4]	[4]
Peru	83	175	[4]	[4]
Brazil	79	54	109	86
Dutch East Indies	36	13	[4]	[4]
Uganda	15	24	38	65

[1]Including linters.
[2]Excluding linters.
[3]Net imports of 81,000 bales reported.
[4]Not available.

The United States, British India, China and Brazil have considerable textile industries of their own, but the other exporting countries, Egypt, Persia, Peru, the Dutch East Indies and Uganda manufacture little or no cotton goods. Although there has been a tendency in recent years for cotton to be increasingly manufactured in the

cotton-growing countries, the main reason for the decrease in the amounts exported was the falling off of buying by the European industrial countries which furnished the chief markets for raw cotton. Large stocks were left on hand in all the important producing countries.

The importance of export trade to the American cotton market is shown by the fact that prior to the war 60 per cent. of the crop was exported, only 40 per cent. being used at home. The destination of the shipments of raw cotton from the United States is shown in Table D for the five years from 1910 to 1914 and for 1919, 1920 and 1921.

TABLE D—EXPORTS OF COTTON FROM THE UNITED STATES BY COUNTRIES[1]

Country	[2]1910-14 (5-yr. aver.)	[2]1919	[3]1920	[3]1921
		(in 500-lb. bales)		
United Kingdom	3,509,424	3,238,178	2,607,793	1,698,337
Germany	2,514,949	155,829	752,143	1,566,651
France	1,086,620	796,338	668,921	668,457
Italy	500,776	561,700	565,703	557,652
Japan	296,575	881,041	671,869	1,121,224
Spain	269,864	252,152	290,055	279,203
Belgium	183,783	163,789	201,811	193,766
Canada	153,418	166,811	220,658	176,721
Austria-Hungary	96,401	97,219	[4]19,217	[4]3,598
Russia	87,577	310	...	...
Sweden	36,285	86,198	88,111	46,707
Netherlands	24,356	210,522	88,916	95,288
Mexico	21,202	692	47,940	27,598
Portugal	14,180	24,957	13,635	26,601
China	13,369	11,628	11,379	154,571
Other countries	30,825	87,992	110,476	61,853
Total	8,839,604	6,735,356	6,358,627	6,678,227

[1]Figures are for all domestic raw cotton exported, including linters.
[2]Fiscal years ending June 30.
[3]Calendar year.
[4]Including exports to Austria, Czechoslovakia, Jugoslavia, Albania and Fiume.

Of the American exports before the war the United Kingdom took 40 per cent., Germany 28 per cent., France 12 per cent., Italy 6 per cent., Japan 3 per cent. and the

remaining countries 11 per cent. Because of decreased purchases by the three leading customers the annual exports since the war have been over 2,000,000 bales less than the average before the war. In 1921 the distribution was: the United Kingdom 25 per cent., Germany 23 per cent., France 10 per cent., Italy 8 per cent., Japan 17 per cent. and other countries 17 per cent. Except for the United Kingdom, Germany and France, the cotton exports to most countries have been greater since than before the war, the increase in exports to Japan and China in 1921 being especially noteworthy.

India, the second largest grower of cotton, exported 56 per cent. of its crop before the war, 41 per cent. in the year beginning April 1, 1919, 58 per cent. in 1920 and 66 per cent. in 1921.

Forty-two per cent. of the average pre-war exports went to Japan, 69 per cent. in the fiscal year 1919–20, 45 per cent. in the fiscal year 1920–21 and 59 per cent. in the year beginning April 1, 1921. The rest of the exports were sent principally to European countries, none of which took a very large amount. Germany, the second best customer in the years from 1910 to 1914, bought an average of only 280,012 bales. Exports to the chief European countries buying Indian cotton were considerably below the pre-war averages in 1921–22, but exports to Japan and China showed remarkable gains.

Table E shows the exports of cotton from India in the five fiscal years 1909 to 1913 and in the fiscal years 1919, 1920 and 1921, by countries of destination. About three-fourths of the shipments were from Bombay.

The quantities of cotton exported by Egypt in the five seasons from 1909–10 to 1913–14 and in the seasons

TABLE E—EXPORTS OF COTTON FROM BRITISH INDIA BY FISCAL YEARS BEGINNING APRIL 1

Country	1909-13 (5-yr. aver.)	1919	1920	1921
		(in 500-lb. bales)		
Japan	890,678	1,325,852	751,211	1,408,212
Germany	280,012	38,886	161,096	187,793
Belgium	221,329	109,948	194,333	158,641
Italy	185,679	124,154	170,312	123,514
Austria-Hungary	134,162	7,047	27,319	26,781
United Kingdom	99,885	119,231	76,805	28,627
France	95,953	45,754	30,764	45,347
Spain	31,671	34,644	61,264	24,134
China	24,126	72,182	153,427	348,356
United States	6,568	14,197	7,504	7,343
Netherlands	4,713	12,096	9,453	4,292
Other countries	32,032	14,927	16,733	28,393
Total	1,925,808	1,918,918	1,660,221	2,391,433

1918–19, 1919–20 and 1920–21 are shown by countries in Table F.

The United Kingdom took 44 per cent. of the exports before the war, 47 per cent. in 1919–20 and 50 per cent. in 1920–21. Exports to the United States grew from 12 per cent. of the total in the pre-war period to 35 per cent. in 1919–20, but in 1920–21 declined to 12 per cent. again. This cotton is used in the United States to supplement the domestic supply of long staple. Its chief use is in the manufacture of automobile tires.

As its cotton is of high grade Egypt, although a large purchaser of cotton goods, uses little of its own cotton. Practically all of it is exported, Alexandria being the port of shipment. Because of the falling off in this international demand, however, Egypt was able to export only a little over one-half of its 1920 crop in 1920–21. The business depression thus brought about emphasized the necessity of having more than one crop to rely on. Consequently, while the British Empire Cotton Growing Com-

mittee is making every effort to increase the supply of cotton grown within the Empire, Egyptian government regulations have been issued restricting the three crops from 1921 to 1923 so that no more than a third of the area of each holding may be planted with cotton. It was estimated that this restriction of acreage would reduce the crop by about a quarter. That the 1921 crop was 45 per cent. less than in 1920 was due to decreased use of fertilizer, activities of the pink boll worm, and other adverse conditions, as well as to reduced acreage.

TABLE F—EXPORTS OF COTTON FROM EGYPT BY SEASONS ENDING AUGUST 31

Country	1910-14 (5-yr. aver.)	1919	1920	1921
	(500-lb. bales)			
United Kingdom	605,958	691,500	520,201	335,831
United States	160,854	143,274	385,859	77,050
Austria	151,340	...	...	[1]9,779
France	133,905	118,044	75,334	62,141
Russia	108,402	...	...	...
Italy	87,499	74,189	78,375	32,655
Spain	29,904	15,696	13,242	22,065
Netherlands	28,932	15	2,769	1,178
Japan	27,400	33,329	21,441	28,104
Germany	26,755	...	8,834	41,142
Other countries	10,990	4,290	3,682	59,959
Total	1,371,939	1,080,337	1,109,737	669,904

[1]Including 4,294 bales to Czechoslovakia.

UNITED KINGDOM LEADING IMPORTER

Table G shows the net imports of cotton, that is, the total imports minus the total exports, into the principal importing countries before the war and in 1919, 1920 and 1921. The United Kingdom was by far the leading importer until 1921. Germany ranked second in the pre-war period, with Japan third, France fourth and Italy fifth. In 1921

Japan was the leading importer. This change from the pre-war position was due to a decrease of 49 per cent. in the net imports into the United Kingdom as well as a gain of 72 per cent. in Japanese gross imports.

TABLE G—NET IMPORTS OF COTTON INTO THE PRINCIPAL IMPORTING COUNTRIES

Country	1909-13 (5-yr. aver.)	1919	1920	1921
	(in thousands of 500-lb. bales)			
United Kingdom	3,981	3,674	3,295	2,043
Germany	1,812	[1]	611	1,370
Japan	1,333	2,068	2,028	2,295
France	1,074	885	892	781
Italy	856	788	788	696
Austria	854	[1]	[2]325	[3]505
Russia	847	[1]	[1]	[1]
Spain	365	325	355	372
Belgium	221	227	447	190
Canada	150	171	230	174
Netherlands	126	104	110	113
Switzerland	108	110	93	109
Sweden	88	71	104	56
Portugal	75	33	[1]	[1]
Finland	35	28	29	32
Denmark	25	30	21	16
Norway	16	21	11	7
Poland	[1]	[1]	101	152

[1]Not available.
[2]Gross imports.
[3]Including Austria and Czechoslovakia.

Three-quarters of the cotton imported into the United Kingdom from 1909 to 1913 was bought from the United States. Egypt, British India, Brazil, Peru and British East Africa came next in the order named. Table H shows, by countries, the quantities of cotton imported into and reëxported from the United Kingdom from 1909 to 1913 and in 1919, 1920 and 1921. The figures for 1920 and 1921 are not strictly comparable with those for previous years because of a change in classification so that in those

years linters and cotton waste were excluded from the cotton item. On the old basis the total imports for 1921 were 2,407,166 bales, while the net imports were 2,094,134 bales.

TABLE H—RAW COTTON TRADE OF THE UNITED KINGDOM

Item and country	1909-13 (5-yr. aver).	1919	1920[1]	1921[1]
	(in 500-lb. bales)			
Imports				
United States	3,417,058	2,741,481	2,780,667	1,602,005
Egypt	799,633	842,740	575,408	[2]462,583
British India	148,445	127,207	148,435	[3]30,130
Brazil	60,300	10,261	46,336	32,692
Peru	53,017	92,971	130,606	[4]
British East Africa	16,062	19,965	30,888	[4]
British West Africa	8,061	12,329	12,982	[4]
British West Indies	5,453	4,023	5,016	4,022
Other countries	31,454	65,596	64,107	213,672
Total imports	4,539,483	3,916,573	3,794,445	2,345,104
Reëxports				
Russia	207,440	18,555	41,084	...
United States	186,109	104,656	209,035	69,422
Belgium	40,870	12,936	25,373	14,250
British India	28,866	...	1,444	[4]
Germany	21,150	14,666	72,022	44,315
Portugal	16,268	6,395	11,757	16,144
Sweden	19,783	4,748	11,375	10,065
France	10,039	35,019	53,572	6,359
Other countries	28,419	45,288	73,683	141,340
Total reëxports	558,944	242,263	499,345	301,895
Net imports	3,980,539	3,674,310	3,295,100	2,043,209

[1]Exclusive of linters and waste.
[2]Exclusive of imports from Anglo-Egyptian Sudan.
[3]Including small shipments from Ceylon and elsewhere in British East Indies.
[4]Not reported separately; included in "Other countries."

Germany, like the United Kingdom, took by far the larger part of its supply of raw cotton from the United States before the war. In the five-year period from 1909 to 1913 the imports from America were 77 per cent. of the total. British India was the next leading source, while

Egypt and China ranked third and fourth respectively. The average annual imports into Germany from 1909 to 1913 and the average reëxports for the same period are shown by countries in Table I. Details for later years are lacking, but in 1920 total raw cotton imports amounted to 614,000 bales and reëxports to 3,000 bales, and in 1921 imports were 1,433,000 bales and reëxports 73,000 bales.

TABLE I—RAW COTTON TRADE OF GERMANY

Item and country	1909–13 (5-yr. aver.) (in 500-lb. bales)
Imports	
United States	1,550,285
British India	261,328
Egypt	172,144
China	11,170
Dutch East Indies	5,504
Turkey	4,301
Other countries	12,294
Total imports	2,017,026
Reëxports	
Austria-Hungary	95,744
Russia	51,810
Netherlands	16,451
Switzerland	12,574
Italy	8,248
Denmark	4,944
Other countries	15,088
Total reëxports	204,859
Net imports	1,812,167

Table J, which gives the imports of raw cotton into Japan by countries of shipment for the years from 1909 to 1913 and for 1919, 1920, 1921, shows that although British India holds the chief place as a source for Japan's raw cotton, the cotton bought from the United States is of increasing importance. For the average of the pre-war years India furnished 60 per cent. of the total cotton imports and the United States 22 per cent. In 1921, how-

ever, 51 per cent. came from India while 40 per cent. was imported from America. Reëxports of raw cotton have grown remarkably, but they still constitute only a small part of the total imports.

TABLE J—RAW COTTON TRADE OF JAPAN[1]

Country	1909-13 (5-yr. aver.)	1919	[2]1920	[2]1921
		(in 500-lb. bales)		
British India......	794,584	945,180	1,109,761	1,165,815
United States......	290,419	823,798	866,007	922,273
China............	194,014	261,937	53,831	148,278
Egypt............	27,403	32,333	[3]18,493	[3]39,613
Chosen...........	4,859	23,012	[4]	[4]
Straits Settlements.	5,574	6,416	3,815	7,637
Dutch East Indies..	4,580	2,808	1,066	1,242
French Indo-China.	11,583	1,608	764	9,005
Other countries....	2,174	2,657	[4]9,581	[4]1,554
Total imports..	1,335,190	2,099,749	[4]2,063,318	[4]2,295,417
Reëxports.....	1,703	31,849	35,390	[5]
Net imports...	1,333,487	2,067,900	2,027,928	[5]

[1]Unginned cotton reduced to ginned at ratio of 3 pounds unginned to 1 pound ginned.

[2]Ginned and unginned cotton not reported separately by countries. Country distribution estimated on assumption that all cotton from the Straits Settlements and the Dutch East Indies, and part of that from French Indo-China was unginned.

[3]Reported as from "African countries."

[4]Figures for Chosen are not available for 1920 and 1921, and are not included in the item "Other countries" or in the total for those years.

[5]Not available.

Despite its preëminent position as the leading producer and exporter of cotton the United States imports a certain amount of cotton for special purposes. Table K shows the imports by country of production for the years 1913, 1919, 1920 and 1921.

Most of the cotton imported is Egyptian, which is used on account of the strength imparted by its long staple for mercerizing or for the manufacture of thread or automobile tires. Because of the ecru shade of some varieties they are used for the manufacture, without dyeing, of

TABLE K—TOTAL IMPORTS OF COTTON INTO THE UNITED STATES BY COUNTRIES OF PRODUCTION

Country	1913	1919 (in 500-lb. bales)	1920	1921
Egypt	167,801	203,006	359,789	145,787
China	14,505	18,391	58,823	3,582
Peru	12,786	46,985	50,913	25,961
Mexico	7,132	61,780	76,169	78,429
British India	5,241	9,949	14,088	3,817
Other countries	2,495	10,606	40,207	20,321
Total	209,960	350,717	599,989	277,897

balbriggan underwear and lace curtains. Considerable quantities of Mexican cotton are imported, principally because of its proximity. At a number of border points, especially in the Imperial Valley, Mexican seed cotton is brought into the United States for ginning.

Chinese and Indian cottons are distinctly inferior to the American variety, but are brought in for use, to some extent at least, for mixing with the higher priced domestic cotton. The Peruvian cotton imported is largely "Rough Peruvian," used principally for mixing with wool.

WORLD CONSUMPTION OF COTTON

Even before the war there was a growing tendency for the cotton-producing countries to manufacture their own cotton goods. To an ever-increasing extent the United States, India, China, and Brazil were becoming independent of the cotton-manufacturing industries of Europe, especially with regard to the coarser kinds of goods. The war accelerated this movement while at the same time it enabled the Japanese greatly to expand their market.

Table L shows estimates of the world's cotton consumption by leading countries in the seasons from 1909–10 to 1920–21. Satisfactory consumption statistics for the

individual countries of continental Europe have been lacking since the outbreak of the war. The average consumption in Germany during the five pre-war years from 1909 to 1913 was 1,741,000 bales, in Russia 1,589,000 bales, in France 984,000, Italy 841,000, and in Austria-Hungary 796,000 bales. For later years the net imports shown in Table G give an indication of the quantities that were available for consumption.

TABLE L—COTTON CONSUMPTION BY PRINCIPAL COUNTRIES

Country	1909–10 to 1913–14 (5-yr. aver.)	1914–15	1915–16	1916–17	1917–18	1918–19	1919–20	1920–21
				(in thousands of 500-lb. bales)				
United States...	5,099	5,678	6,469	6,840	6,598	5,831	6,474	4,955
United Kingdom.	4,049	3,890	4,000	4,030	3,280	2,725	3,700	2,040
Continental Europe.......	6,949	6,250	6,400	4,616	3,050	2,975	3,660	4,400
British India....	1,704	1,607	1,660	1,764	1,775	1,627	1,646	1,840
Japan..........	1,250	1,400	1,650	1,850	2,000	1,870	1,825	1,800
Canada.........	128	185	208	191	250	198	220	150
Other countries..	847	1,000	900	1,180	1,035	1,000	1,200	1,250
Total......	20,026	20,010	21,287	20,471	17,988	16,226	18,725	16,435

The importance of a nation's cotton-manufacturing industry is not to be measured solely by the quantity of raw material consumed. Too much depends upon the quality of the raw material and of the products made from it. In order to show the machinery equipment of the more important cotton-manufacturing countries Table M presents the number of spindles by countries for the season just before the war, 1913–14, and for the season seven years before and after, 1906–07 and 1920–21.

The total number of spindles increased only 5 per cent. between the seasons ending in 1914 and 1921 although during the preceding seven years the increase was 19 per

TABLE M—COTTON SPINDLES IN THE PRINCIPAL COUNTRIES

Country	1906-07	1913-14 (000 omitted)	1920-21
United Kingdom	50,680	56,300	56,140
United States	26,375	32,107	36,620
Germany	9,339	11,550	9,400
France	6,800	7,410	9,600
Russia	6,500	9,160	7,100
British India	5,280	6,500	6,770
Austria-Hungary	3,616	4,970	[1]4,720
Italy	3,500	4,620	4,500
Spain	1,850	2,210	1,800
Switzerland	1,484	1,380	1,530
Japan	1,483	2,750	4,130
Brazil	1,300	1,250	1,520
Belgium	1,140	1,530	1,550
Canada	800	965	1,370
China	750	1,000	1,800
Poland	[2]	[2]	1,160
Other countries	2,436	2,695	3,300
Total	123,333	146,397	153,010

[1]Including Austria 1,140,000 spindles and Czechoslovakia, 3,580,000 spindles.
[2]Not available.

cent. Since the British mills, in general, spin finer counts of yarns than American mills the quantity of cotton consumed per spindle is less. Thus while America consumes the most cotton Great Britain has the largest number of spindles in the world. Operation day and night and the manufacture of the coarser kinds of goods enable Japan to consume large quantities of cotton with relatively little equipment. That country, however, is rapidly adding to its number of spindles.

TREND OF COTTON PRICES

Through 1913 and in the first part of 1914 cotton prices at New Orleans, the principal spot market, ranged between 12 and 14 cents a pound for middling cotton. The exchange was closed upon the outbreak of the war, but when

trading was resumed a low point of $6\frac{1}{2}$ cents a pound was reached on October 24, 1914. This prevailed until the 28th when the price began its gradual climb to $41\frac{3}{4}$ cents, which was the quotation from April 16 to 19, 1920. The course of prices is traced in Table N, which shows the closing quotations for middling cotton at New Orleans by months from 1913 to 1921. Middling is the grade which forms the basis for cotton quotations. American cotton with the ordinary length of staple is rated above or below middling according to the amount of leaf, dirt, sand, motes and other extraneous matter it contains, together with its color. A bright creamy color is most desired, but weather and soil conditions often cause cotton to become "off color," "tinged" or "stained," so that it is reduced in grade. The length of staple is considered apart from the grade, cotton that averages $1\frac{1}{8}$ inches or more in length of staple usually being called "staple" cotton or "long-staple" cotton. The great bulk of this cotton is grown in the Mississippi or Yazoo Delta which forms the western part of the State of Mississippi.

TABLE N—CLOSING QUOTATION FOR MIDDLING COTTON AT NEW ORLEANS ON THE AVAILABLE DATE NEAREST THE FIFTEENTH OF EACH MONTH FROM JANUARY, 1913, TO DECEMBER, 1921

Month	1913	1914	1915	1916	1917	1918	1919	1920	1921
				(in cents per pound)					
January	12.50	12.88	7.75	12.19	18.00	31.75	29.00	40.25	15.00
February	12.56	13.00	8.06	11.56	17.19	30.38	26.75	39.25	13.25
March	12.50	13.00	8.44	11.88	17.63	32.50	27.50	41.00	10.75
April	12.50	13.13	9.37	11.88	19.81	33.00	26.75	41.50	11.25
May	12.31	13.25	9.00	12.75	19.63	29.25	28.13	40.25	11.88
June	12.50	13.94	9.38	12.69	24.19	31.00	31.63	40.75	11.25
July	12.44	13.31	8.50	13.00	25.88	30.00	34.25	39.00	11.88
August	12.00	[1]	9.00	14.00	25.75	29.50	30.88	34.50	12.13
September	13.00	[1]	10.25	15.13	20.19	33.50	29.00	28.50	19.50
October	13.25	6.75	12.00	16.81	27.13	30.75	35.00	20.25	19.00
November	13.31	7.75	11.44	19.50	28.00	29.38	39.50	18.25	16.00
December	13.00	7.00	11.82	18.00	29.00	29.00	39.75	14.75	16.75

[1] No quotation, exchange closed.

INTERNATIONAL TRADE IN COTTON PIECE GOODS

The United Kingdom, the United States and Japan are the chief exporters of cotton piece goods. Before the war France, Italy, Germany and the Netherlands were likewise large exporters, but excepting France these countries had not recovered their pre-war position by the end of 1921. British India and China are the leading importers, although the development of domestic cotton manufacturing is lessening their import needs, especially with respect to the coarser kinds of goods, which form the bulk of their purchases and which can readily be made from the short-staple native cottons. The world's average annual production, consumption, exports and imports of cotton piece goods by leading countries, for the pre-war years from 1910 to 1913, as estimated by the Research Committee of the National Council of Cotton Manufacturers, are shown in Table O.

No later compilation is available, but it is probable that Great Britain, though still the largest exporter, no longer furnishes as much as two-thirds of the world's total exports. American and especially Japanese exports have expanded greatly while British shipments have fallen off since 1913.

Table P, giving the quantity of piece goods exported from the United Kingdom in 1913, 1919, 1920 and 1921, by countries of destination, shows the decline in total exports in 1921, as compared with 1913, to have been about three-fifths. The decrease was especially heavy in the trade with India and China, which were usually Great Britain's best customers. So marked was the decline in exports to China in 1921 that Egypt replaced China as

TABLE O—AVERAGE ANNUAL PRODUCTION, CONSUMPTION, EXPORTS AND IMPORTS OF COTTON PIECE GOODS FROM 1910 TO 1913

Country	Production	Consumption (in millions of pounds)	Exports	Imports
United States	1,900	1,812	99	11
United Kingdom	1,400	304	1,120	24
Russia	678	657	30	9
Germany	650	579	88	17
China	604	819	..	215
British India	530	998	22	490
France	353	263	94	4
Japan	342	287	70	15
Italy	312	227	92	7
Austria-Hungary	295	271	27	3
Brazil	125	150	..	25
Spain	125	115	12	2
Netherlands	97	31	73	7
Belgium	77	75	12	10
Mexico	66	74	..	8
Canada	50	74	..	24
Turkey	25	140	1	116
Dutch East Indies	4	94	..	90
Argentina	..	66	..	66
Other countries	184	781	15	612
Total	7,817	7,817	1,755	1,755

the second leading buyer. Exports to the United States and Morocco, on the other hand, showed increases over 1913.

TABLE P—EXPORTS OF COTTON PIECE GOODS FROM THE UNITED KINGDOM

Country	1913	1919 (in millions of yards[1])	1920	1921
British India	3,057	768	1,374	1,092
China, including Hongkong	717	304	453	211
Turkey	361	333	263	56
Dutch East Indies	305	124	209	159
Egypt, including Anglo-Egyptian Sudan	267	185	297	220
Argentina	199	108	162	103
Australia	168	75	138	115
British West Africa	145	115	135	55
Straits Settlements	132	51	101	42
Morocco	60	57	43	65
United States	44	41	102	55
Other countries	1,620	1,363	1,158	730
Total	7,075	3,524	4,435	2,903

[1]Figures for 1920 and 1921 are in millions of square yards.

In the year beginning April 1, 1913, British India imported 3,159,000,000 yards of piece goods besides fents. Of this amount the United Kingdom supplied 97 per cent. Imports from the United States and Japan together made up less than 1 per cent. of the total. While important amounts were brought from the Netherlands, Italy, Switzerland, Belgium, Germany and other European countries, America and Japan were destined to become, except for Great Britain, the principal sources of India's imports of cloth. Purchases from Japan grew from 9,000,000 yards in 1913–14 to 170,000,000 in 1920–21 and 90,000,000 in 1921–22. Imports from the United States showed no gain until 1921–22, when 21,000,000 yards were bought as contrasted with 10,000,000 yards in 1913–14. In 1921–22 the United Kingdom furnished 88 per cent. of the imports, Japan 8 per cent., and the United States 2 per cent.

The imports of cotton piece goods into British India from the United Kingdom, the United States and Japan are shown in Table Q for the fiscal years 1913–14, 1919–20, 1920–21 and 1921–22. Total imports of fents, or remnants, which are not separated by countries in the later trade returns, are shown as a whole.

TABLE Q—IMPORTS OF COTTON PIECE GOODS INTO BRITISH INDIA BY FISCAL YEARS BEGINNING APRIL 1

Country	1913	1919 (in millions of yards)	1920	1921
Total piece goods except fents—				
United Kingdom	3,068	963	1,278	947
United States	10	6	9	21
Japan	9	76	170	90
Other countries	72	19	34	22
Total	3,159	1,064	1,491	1,080
Fents	38	17	18	10
Total piece goods	3,197	1,081	1,509	1,090

Japanese progress in the Indian market has been due, aside from cheap labor, largely to close coöperation between the government, banks, shipping companies, merchants and manufacturers. The chief handicaps to Japanese expansion have been rising labor costs and lack of machinery and capital. India is Japan's second best customer for cotton goods, China ranking first in this respect.

Indian mills furnish the principal competition which the British product encounters in India. They are becoming increasingly important in supplying the domestic demand as the quantity of their output improves. The piece goods turned out are mainly unbleached shirtings made from native cotton. Under war conditions the mills were able not only to compete more successfully in the domestic market, but to develop export markets in the Orient, on the Persian Gulf and the Red Sea, and in East Africa.

Exports of cotton piece goods are not a particularly important part of the total export trade of the United States, as they constituted of late years less than 2 per cent. of the total value of exports. Though the second largest exporter, the United States exported in the years 1910 to 1913 less than one-eleventh of the British shipments. Home consumption was so large that only 5 per cent. of production was shipped abroad.

Table R shows the exports of cotton piece goods from continental United States in 1913, 1919, 1920 and 1921.

American strength in foreign markets for piece goods lies to a great extent in standardization of a narrow range of qualities, mostly unbleached cloths and prints, and the maintenance of a consistently good quality. These goods

can be made on automatic looms, of which there are some 400,000 in the United States, as compared with 15,000 in England. American manufacturers have specialized in quantity production and so far have left it to England to excel in furnishing large assortments of designs in relatively small quantities.

TABLE R—EXPORTS OF COTTON PIECE GOODS FROM THE UNITED STATES

Country	[1]1913	[2]1919	[2]1920	[2]1921
		(in millions of yards)		
Philippine Islands	93	47	63	54
China	80	38	28	25
Aden	25	9	6	15
Canada	27	64	66	43
Mexico	3	28	20	49
Central America	33	55	57	71
Porto Rico	33	37	56	38
Cuba	22	67	161	23
Haiti	20	30	22	21
Dominican Republic	13	13	34	5
British West Indies	10	26	23	28
Argentina	2	32	46	25
Chile	10	19	19	21
Colombia	26	46	83	14
Venezuela	4	17	36	2
Other countries	86	197	161	165
Total	487	725	881	599

[1]Fiscal year ending June 30.
[2]Calendar year.

IRON AND STEEL

IRON is the most abundant of the heavy metals, as well as the one most essential to civilization. The basis of modern industry is steel. Superior iron products and steel were made in medieval times, and the use of the metal dates back to the beginning of recorded history, but the achievement of the nineteenth century was the development of processes which made possible the conversion in a large way of ore to iron and of iron to steel. Individual skill and hand labor are now largely superseded by chemistry and mechanical power.

WORLD'S SUPPLY OF IRON ORE

Metallic iron is usually found in combination with other substances, rarely in the native or pure state. The commercial value of iron ore for smelting depends primarily on the percentage of metal content. Ore containing as high as 72 per cent. of metal is known to exist, and ores which yield as much as 60 per cent. of iron are of a highly desirable grade. Such ores are, however, not plentiful, and by far the greater proportion of the world's supply contains a lower percentage of iron. The average metal content of ores mined in the United States at present is slightly over 50 per cent. The minimum for commercial use is now about 25 per cent. iron content. Quality may be of as much significance as metal content. Ore with a high percentage of iron is in some cases rendered too

costly to smelt by the presence of a small quantity of titanium, while in other ores a low iron content may be compensated by admixture of materials that render the ore self-fluxing. Methods for utilizing the abundant low-grade ores of the United States, which under present conditions do not pay to smelt, are under consideration.

Only the roughest approximation can be made of the world's iron ore resources. Even in North America explorations are by no means complete. According to figures presented before the International Geological Congress at Stockholm in 1910, the actual world reserves of workable ore conforming to the present standard of iron content were more than 10,000,000,000 tons of metallic iron content. Deposits of inferior and less accessible ores were placed at between 50,000,000,000 and 60,000,000,000 tons of metallic iron, and it was further estimated that unexplored regions would bring the entire world possession of actual and potential ore reserves up to 424,000,000,000 tons of metallic iron. These figures were based on detailed explorations in the United States and the greater part of Europe and Japan, partial explorations in certain other regions, and on estimates for the rest of the world. More recently the available resources of Europe and the Americas combined were estimated as 14,310,000,000 tons of metallic iron, this total including some low-grade ores. Limited areas are now being worked in northern and southern Africa, India, Australia, Japan, China, Chosen, the Philippines and other regions, and it is considered probable that extensive reserves, as yet undiscovered, exist in the continents of Asia, Africa and Australia, but too little is known to estimate their total ore content.

On the basis of explorations up to the present time, the

six important ore centers of the world are the Lake Superior region, Lorraine, northern Sweden, Cuba, Newfoundland and Brazil.

The Lake Superior region ranks first in the world as an ore producer containing, according to estimates presented at the Stockholm Congress, 2,000,000,000 tons of metallic iron in readily available reserves and 36,000,000,000 tons in potential reserves. A more recent estimate places the available reserves at 1,430,000,000 tons of metallic iron. These ores are chiefly hematite with an iron content averaging above 50 per cent., but because of the increasing percentage of phosphorus a decreasing proportion of the ores is suitable for the acid Bessemer process.

The minette ores of Lorraine, extending into Belgium and Luxemburg, are second in importance to those of the Lake Superior region. Minette ore furnishes most of the raw material for France's iron industry and formerly, when Germany owned half of it, was also the principal source of ore for the German iron industry. Its available reserves amount to 1,850,000,000 tons metallic iron content. Not only is the iron content of minette ore low, from 27 to 36 per cent., but its phosphorus content is high and consequently pig iron made from it must be smelted by one of the basic processes. The largest known ore supplies which contain 60 per cent. or more of iron are in Sweden. This ore comes from the magnetic deposits of Lapland, largely north of the Arctic Circle, which were estimated in 1910 at over 673,000,000 tons metallic iron. Fields in the southern part of the country furnish ore of the highest quality with a slightly lower percentage of iron. Swedish ores have a wide range of phosphorus content.

Cuba contains actual reserves of about 1,000,000,000

tons metallic iron and probably 500,000,000 tons in potential reserves. The ore is of high grade with phosphorus content low enough to be within the Bessemer limit, but the mines have as yet been little developed. Newfoundland has enormous submarine deposits in Conception Bay, with small outcroppings on Bell Island. It is good ore, easily reduced. The available reserves are estimated at 1,750,000,000 tons metallic iron content.

The Brazilian ore fields form perhaps the most important undeveloped iron area of the world and rank among the six most important ore centers. Estimates made of these ore deposits vary from 3,500,000,000 tons of ore to as high as 7,500,000,000 tons. The ore is very rich, a great proportion containing iron oxide up to 97 per cent. The deposits have not been developed sufficiently to justify an exact statement as to the total metallic iron content but the State of Minas Geraes alone is believed to have in its ore fields more iron than that in all Europe. An obstacle to mining development is the inaccessibility of the deposits under present conditions of transportation. Most of the Brazilian ore will have to be exported for smelting unless adequate supplies of coking coal are discovered in the country or hydro-electric developments, which are already begun, provide sufficient cheap power. British and American capital have for some time controlled certain important holdings in Brazil, and German and Luxemburg interests are adding to their smaller properties there. Brazilian ore will be especially valuable to the British industry which requires an ore low in phosphorus.

The United States has, besides the Lake Superior region, three other main ore regions. They are the Eastern region, containing the so-called Clinton ores, the Mississippi

Valley and the Cordilleran or mountain regions of the West. American ore containing 60 per cent. or more of iron is insignificant in amount and is rapidly disappearing. The supply of 50 per cent. ore is sufficient for many years to come, and there are very large reserves of 40 per cent. and lower grade ore.

Allowing for pig iron production at the rate of 70,000,000 tons a year, it is estimated that the available ore resources of Europe and North and South America will last 200 years, but with even a low rate of increase in annual pig iron production, the duration of the supply as at present estimated would be much shortened. There seems no doubt, however, that exploration will reveal vast additions to the present known supply. Table A summarizes the actual reserves in the leading countries of ore which conforms to present standards of iron content and which would be considered workable by practical metallurgists. The estimates are those prepared for the International Geological Congress in 1910, together with later estimates for European countries published by the United States Geological Survey. No potential reserves or estimates for imperfectly explored areas are included. Thus it will be noted that Brazil does not appear in the list of countries.

The geographical location of iron and steel industries is determined primarily by advantages in assembling raw materials and secondarily by advantages in distributing finished products in domestic and foreign trade. In addition to ore supply, chief requisites for the establishment of a steel plant are fuel and limestone (or some other fluxing material), labor supply and transportation facilities. In some favored regions, as in the British Isles, along the Rhine, and in the Birmingham, Alabama, district, coal

and ore deposits are found in close proximity. When this is not the case, the rule has been that "Iron goes to coal." Swedish and Spanish ores have for years moved to the fuel and blast furnaces of England and Germany. Foreign ores, chiefly from Spain and northern Africa, now

TABLE A—IRON CONTENT OF PRINCIPAL KNOWN IRON ORE RESERVES

	Pre-war estimates (Stockholm Congress, 1910)	Post-war estimates[1]
	(in millions of tons)	
United States	2,305	2,935
Newfoundland	1,961	1,750
Cuba	857	1,080
Great Britain	455	318
France	1,140	1,790
Germany	1,270	256
Luxemburg	90	60
Sweden	740	443
Russia	387	[2]199
Spain	349	353
Norway	124	86
Austria	90	77

[1]Estimate for United States from *Mineral Industry*, 1918; Newfoundland and Cuba estimates adopted by F. H. Hatch, 1920; other countries from Bulletin 706, U. S. Geological Survey.

[2]Central Russia, Ural region and Caucasus, excluding the Ukraine and Finland.

furnish about one-third of the supply used in the British industry, freight rates being kept at a minimum by utilization of ore-carrying vessels to take coal as return cargo. Lake Superior ores are handled three times and carried almost 1,200 miles by rail and water to the great coal fields around Pittsburgh, a distance longer than that from Spanish mines to British furnaces. While Minnesota and Michigan produce over 80 per cent. of all ore mined in the United States, their smelting industry is small and 60 per cent. of the country's pig iron output is made in Pennsylvania and Ohio.

Hydro-electric power as a substitute for coal in ore re-

duction may bring about far-reaching developments in the steel industry if costs can be reduced. With the introduction a century ago of coke as fuel for blast furnaces, replacing charcoal, supremacy passed from Sweden to England. Electric smelting offers possibilities for the utilization of important ore fields for which no convenient coal supply exists. This method has risen to potential importance in comparatively recent years, one form of it having been developed in Sweden in 1910. Costs of electric smelting have been found relatively high and thus far the coke-fired blast furnace has held its own in countries where fuel is readily obtainable. Brazil, with its unsurpassed water-power resources and rich ore deposits, has already made a small beginning in electric smelting and is using electric power in other lines of industry because of the insufficiency of domestic coal. As government policy definitely encourages domestic manufacture, it seems only a question of capital and time for installation until a steel industry may be created in Brazil independent of imported fuel.

Labor can be transported to sparsely populated localities when other conditions favor industrial development, and new enterprises in turn help to build up population. It is evident, however, that iron and steel manufacturing has thus far developed almost exclusively in well populated countries which afford a market as well as a labor supply. While Japan, China, and British India lead Western nations at present in the available supply of cheap labor, the unsettled condition of the labor situation in the Orient points to the possible removal of this apparent advantage. A low wage scale, moreover, does not insure low labor costs per unit of output and it should

not be assumed that cost of production will be smaller in the East than elsewhere.

Of hardly less importance in the geographical location of the industry than supply of raw materials and labor is the matter of distribution of finished products in domestic and foreign trade. Cheap water transportation by rivers and canals gives the steel industries of Great Britain, Germany, Belgium and northern France easy access to shipping ports and consequently to foreign markets, while steel products from Pittsburgh and Youngstown must bear the cost of a rail haul of several hundred miles to seaboard before they can be loaded for Europe or the Orient. In general the steel industry of Europe has better facilities for entering foreign trade than has the American industry. The latter, on the contrary, has a far more extensive domestic market than is the case in any European country. The bulk of the steel manufacturing in the United States is carried on in the interior where finished products can be easily distributed in the home market, only a small part of the industry being at seaboard. Future development of the St. Lawrence Canal route may provide water transportation for an important steel district. For the future it is predicted in some quarters that more consideration will be given to accessibility of ore supply and markets than has heretofore been the rule.

The movement of iron ore in international trade is usually subordinate to its consumption in the producing countries. Leading steel-making countries, with the exception of Germany and Belgium, depend primarily on native ores and only secondarily on imported supplies. From the standpoint of ore-producing countries, the determining factor in the question of home manufacture

versus exportation of ores is cost. European ore movements will probably continue to be influenced by convenience and cost of transportation more than by political boundaries and ore will generally be smelted where it can be done most cheaply, taking all elements of cost into consideration. The accompanying table shows production, imports and exports of ore of a number of countries

TABLE B—PRODUCTION, IMPORTS AND EXPORTS OF IRON ORE BY LEADING COUNTRIES, 1913, 1919 AND 1920

	1913	1919 (in tons[1])	1920
Production			
United States	61,980,437	60,965,418	67,604,465
United Kingdom	15,997,328	12,254,195	12,707,475
Germany	28,607,900	6,153,800	6,361,600
Luxemburg	7,333,372	3,112,472	3,704,390
France	21,918,000	9,340,000	13,871,187
Belgium	150,450	4,820	17,260
Sweden	7,475,571	4,981,110	4,519,112
Spain	9,861,668	4,640,061	4,767,693
Imports			
United States[2]	2,246,353	476,461	1,273,456
United Kingdom	7,442,249	5,200,696	6,499,551
Germany	14,019,045	[3]	6,450,421
Luxemburg		611,139	1,016,079
France	1,410,424	303,853	404,725
Belgium	7,085,163	724,930	2,450,367
Sweden	2,909	..	762
Spain	[4]	[4]	[4]
Exports			
United States[2]	1,224,112	996,569	1,145,037
United Kingdom	6,378	2,364	2,095
Germany	2,613,158	[3]	160,520
Luxemburg		1,207,510	2,042,889
France	10,066,628	1,997,171	4,839,516
Belgium	724,765	15,520	152,808
Sweden	6,439,750	2,416,856	3,728,623
Spain[5]	8,907,309	3,702,648	4,630,662

[1]For United States and United Kingdom, gross tons of 2,240 pounds; other countries metric tons of 2,204.6 pounds.

[2]Fiscal year ending June 30, 1913; calendar years 1919 and 1920.

[3]Not available.

[4]Imports nil or negligible.

[5]Exclusive of pyrites.

before and after the war. The year 1913 is chosen for comparison with the post-war period as in many countries that year marked the culmination of a period of steadily increasing production.

PRODUCTION OF PIG IRON AND STEEL

The world's production of pig iron between 1800 and 1910 increased at an average of about 60 per cent. in each decade. Since 1910 it has increased very little and the record output in 1913 has not been equaled in the post-war period. Fundamental changes in the status of European countries were brought about by the redistribution of territory after the war.

The commercial supremacy of steel over iron is a development of the nineteenth century, for until the invention of the Bessemer converter process in 1855, the only steel available was that made in small quantities at high cost by the case-hardening, crucible and cementation processes. The open-hearth furnace, perfected by Siemens soon after 1860, brought further progress in the direction of economical quantity production, as it made possible the use of pig iron smelted from ores which were unfit for the making of Bessemer pig. By 1877 more steel rails were made in the United States than iron rails and as the demand for steel expanded the manufacture of iron products has gradually assumed the position of a specialty business. The electric steel furnace, introduced at the close of the century, is used chiefly for making tool and special alloy steels because of the exactness with which its operation can be controlled.

An important economy in steel manufacture is effected by the use of a large proportion of scrap with pig iron in

the open hearth process. To this method is due the production in several recent years of an annual output of steel greater than that of pig iron. Scrap can also be used for steel making in the electric furnace. The utilization of old material and scrap from manufacturing to swell the volume of steel is particularly valuable to industry at a time when the exhaustion of high-grade ore reserves is in prospect.

The world's production of pig iron in 1800, 1850 and certain later years and steel production in a number of years beginning with 1870 are shown in table C. Figures for 1900 and earlier are rough estimates rather than exact totals. For later years official estimates have been used wherever possible in compiling world production. While production by the most important countries is included, a world total is of necessity only an approximation.

TABLE C—WORLD PRODUCTION OF PIG IRON AND STEEL

Year	Pig Iron (in thousands of gross tons)	Steel
1800	825	[1]
1850	4,750	[1]
1870	11,900	692
1900	38,973	28,273
1910	65,240	59,679
1911	63,013	59,783
1912	72,258	72,137
1913	77,717	75,424
1914	59,337	59,800
1915	59,294	65,715
1916	72,121	81,847
1917	70,481	83,634
1918	64,975	76,540
1919	49,628	54,918
1920	58,713	67,995
1921	35,415	40,491

[1]Not available.

CHIEF PRODUCING COUNTRIES

The foremost producer of iron and steel is the United States. This supremacy was won in 1894 when for the first time the quantity of pig iron and steel made in the United States exceeded the production of the United Kingdom. Except in two years of industrial depression the record has been held until the present time. From 1916 to 1920 the United States produced as much pig iron as all other countries combined. Germany, the United Kingdom, and France follow, the order given being that of standing in the post-war period.

Belgium and Luxemburg are important not so much for the bulk of their output as for their relatively large surplus above domestic needs. The steel industry of Luxemburg was formerly closely connected with that of Germany. Austria and Russia have lost the pre-war productivity which represented a considerable contribution to the world's total, although production in those countries was principally for home consumption. In the succession states of the Austrian Empire rehabilitation of the iron and steel industry is going forward but in Russia, so far as can be learned, almost total paralysis of the industry has occurred. Ore exports overshadow Sweden's iron and steel manufacture, which is largely given over to specialties for export, while ordinary products are imported for home use. Spain is trying to increase the smelting of native ores. Canada has lately reached a position of significance and is ambitious for the future. Japan, British India and Australia have small industries, China and South Africa still smaller ones with the prospect of growth. The progress of India's manufacturing may well be considerable

in view of the character and extent of natural resources. Italy maintains an industry by importing raw materials and scrap at heavy cost. In Brazil the manufacture of iron and steel has not advanced beyond the initial stages.

From the international standpoint the chief factors in production are the United States, United Kingdom, France, Germany and Belgium. Interest centers, since the war, on the change in relative position of France and Germany which is illustrated by the reduced post-war production of the latter shown in tables D and E. Through the recovery of Lorraine Annexée, France completes her control of all the ore fields in the Lorraine basin except the small area held by Luxemburg. Lorraine ores, together with those of Normandy, Brittany, Anjou and other districts, place France next to the United States in ore reserves and foremost in all Europe. Fields retained by Germany contain known reserves amounting to about one-seventh of the French reserves. French ore-producing capacity is theoretically around 40,000,000 tons annually, which with sufficient blast furnaces and fuel would provide for over 10,000,000 tons of pig iron a year. For the present, actual ore and iron output are far below these figures and large ore exports have disposed of part of the production of the mines since the war as in pre-war years. Germany's loss of Lorraine, comprising two-thirds of German ore reserves and 30 per cent. of her blast furnace capacity, leaves the country able to produce a maximum of 13,000,000 to 14,000,000 tons of steel a year if the necessary foreign ore is obtained. Actual output from 1919 to 1921 was much below that figure.

The Luxemburg industry is to some extent controlled by French and Belgian capital. The recent economic

agreement between Belgium and Luxemburg links coal resources of the former to the productive ore fields of the latter. In case the opportunity for combination is embraced by the steel interests in both countries they will furnish active competition to Germany. The accompanying tables show average annual production of iron and steel in the five years 1909 to 1913 by six countries, maximum production in any year, and production for 1919 and 1920.

TABLE D—PRODUCTION OF PIG IRON BY LEADING COUNTRIES

	Maximum Production		1909–1913 5-year average	1919	1920
	Year	Quantity	(in tons[1])		
United States	1916	39,434,797	27,488,335	31,015,364	36,925,987
United Kingdom	1913	10,260,315	9,616,427	7,417,401	8,034,700
Germany	1913	16,761,311	14,042,243	5,654,408	5,550,000
Luxemburg	1913	2,547,861	1,981,589	617,422	692,935
France	1913	5,207,000	4,447,600	2,412,149	3,433,791
Belgium	1913	2,484,690	2,060,070	250,570	1,116,400

TABLE E—PRODUCTION OF STEEL BY LEADING COUNTRIES

	Maximum Production		1909–1913 5-year average	1919	1920
	Year	Quantity	(in tons[1])		
United States	1917	45,060,607	27,255,645	34,671,232	42,132,934
United Kingdom	1917	9,716,544	6,635,600	7,894,000	9,067,300
Germany	1913	17,598,826	14,469,994	6,877,398	7,710,000
Luxemburg	1913	1,336,263	931,053	370,795	584,968
France	1913	4,687,000	4,203,600	2,200,000	3,050,396
Belgium	1912	2,515,040	2,139,894	334,000	1,253,110

[1]Figures for the United States and United Kingdom are in gross tons of 2,240 pounds: for other countries in metric tons of 2204.6 pounds.

STEEL MANUFACTURING

Direct processes of producing steel from ore in a single operation are eagerly sought but their commercial application belongs to the future rather than the present. Under the present system in the United States about 60 per cent. of the pig iron output is delivered in molten condition

from the blast furnace to the converter or open-hearth furnace to be made into steel without loss of heat. Fuel saving by this method is possible only to large industrial units operating both blast furnaces and steel plants and is one of the chief advantages of mass production. Quantities of pig iron delivered in molten condition and by other methods are shown in Table F covering production in the United States for the years 1913 to 1921.

TABLE F—METHODS OF DELIVERY OF PIG IRON PRODUCED IN THE UNITED STATES, 1913 TO 1921

(in gross tons)

Year	Molten Condition	Sand Cast	Machine Cast	Chill Cast	Direct Castings	Total
1913	16,738,708	6,689,680	6,522,171	1,000,171	15,422	30,966,152
1914	11,911,247	4,814,959	5,854,661	738,018	13,359	23,332,244
1915	17,108,891	5,076,469	6,969,108	740,413	21,332	29,916,213
1916	23,101,018	6,584,152	8,278,357	1,442,576	28,694	39,434,797
1917	23,193,439	6,238,567	7,649,684	1,506,394	33,132	38,621,216
1918	23,643,761	5,672,387	8,312,549	1,387,946	38,001	39,054,644
1919	18,217,717	3,962,162	7,985,710	819,554	30,221	31,015,364
1920	22,293,410	4,612,446	9,203,174	784,480	32,477	36,925,987
1921	9,744,475	998,898	5,736,347	195,239	13,167	16,688,126

The open-hearth process was developed in England and on the Continent at about the period of the American Civil War, and its use has rapidly increased both in Europe and in the United States, until it now dominates the industry in the leading steel-producing countries. Table G, summarizes, by five-year totals and by processes, the production of steel in the United States from 1891 to the close of 1921. It will be seen that, while 82 per cent. of all the steel produced in this country during the five years from 1891 to 1895 was Bessemer and only 17 per cent. was open-hearth steel, in 1921 but 20 per cent. was made by the Bessemer method and 79 per cent. was made by the open-hearth process.

TABLE G—PRODUCTION OF STEEL IN THE UNITED STATES BY PROCESSES: FIVE-YEAR TOTALS, 1891 TO 1920, AND 1921

Period	Open Hearth (in gross tons)	Bessemer	All Other	Total	Per cent. of Total: Open Hearth	Per cent. of Total: Bessemer	Per cent. of Total: All Other
1891–1895	3,909,650	19,111,979	357,053	23,378,682	16.72	81.75	1.53
1896–1900	11,483,114	30,275,362	441,213	42,199,689	27.21	71.74	1.05
1901–1905	31,053,491	45,245,009	541,157	76,839,657	40.41	58.88	.71
1906–1910	61,365,323	48,803,689	664,905	110,833,917	55.37	44.03	.60
1911–1915	98,833,090	42,329,520	729,739	141,892,349	69.65	29.83	.52
1916–1920	159,644,300	47,069,884	2,386,701	209,100,885	76.35	22.51	1.14
1921	15,549,802	4,015,938	178,057	19,743,797	78.76	20.34	.90

By the open-hearth process the composition of steel can be better controlled than by the Bessemer method. The increase in the use of the basic open-hearth process in the United States and elsewhere has been accelerated by the fact that pig iron for use in this method may vary widely as to its phosphorus content, while the possible range of phosphorus content for pig iron to be converted either by the acid Bessemer or basic Bessemer process is limited.

A very important feature of both the basic and acid open-hearth processes is the use of scrap in making steel. By the acid open-hearth process as much as 75 per cent. scrap has at times been used. In the United States, where by far the larger proportion of steel is produced by the basic open-hearth process, and in the United Kingdom it was formerly believed that good basic open-hearth steel could not be made if over 50 per cent. of the charge was scrap. During the war years both the presence of large quantities of scrap and, in some countries, a shortage of pig iron, greatly stimulated efforts to develop a technique by which the proportion of scrap to pig iron used in the production of steel might be increased. It has now been demonstrated that it is possible to use more than half scrap in the basic open-hearth process with satisfactory

results. The price of scrap in relation to cost of production of pig iron will be a factor in future development, but there is every evidence that the limits of the use of scrap have been by no means reached.

The technical changes which have taken place in steel making in the United States are clearly reflected in the ratio between pig iron output and steel production. During the five years from 1891 to 1895, one and three-fourths tons of pig iron, including non-steel-making iron, were produced to every ton of steel. The ratio of pig-iron production to steel output fell very rapidly during the last decade of the nineteenth century. Since that time, although the decline has been less rapid, it has been consistent, until in 1921 less than nine-tenths of a ton of pig iron for all purposes was produced for each ton of steel.

The manufacture of pig iron from ore is practically limited to a single process, smelting in the blast furnace. In the second stage, from pig iron to ingots, there is little variation; the two principal methods, using the Bessemer converter or the open-hearth furnace, account for the bulk of the output and the product is always an ingot for further working, or a finished casting. The tonnage of ingots and castings together measures the output of crude steel. After the ingot stage diversification begins. Semi-finished steel is in the form of blooms, billets, slabs, sheet bars, and tinplate bars, while all other rolling mill products are known as finished rolled steel. The rolling mill is the last division of the steel industry, as distinguished from the manufacturing groups which produce locomotives and cars, automobiles, machinery and tools, etc.

Domestic demand differs widely in the chief producing

countries. The American industry has at its very doors the greatest market in the world for steel. Development of this country as a manufacturing nation is not complete, and iron and steel are required for machinery and for all forms of plant equipment in increasing amounts for domestic uses. Large quantities are being used in the manufacture of machinery for the export trade. The railroad mileage of the United States is over a third of the total mileage of the world, and it has been roughly estimated that consumption by railroads of the United States requires from one-sixth to one-third of the entire domestic steel output. The use of steel as a structural material, especially with concrete, has been carried further here than in any other country.

INTERNATIONAL TRADE

The international demand, as distinguished from the domestic demand, for iron and steel is created by importing countries which belong to three main classes. Those countries where industrial development is in progress but where the domestic production of iron and steel products is not commensurate with growing needs, are heavy importers. Australia, Canada and Japan are typical of this class. A second group of importing countries consists of those with relatively little industrial development. Iron and steel and their manufactures, including machinery, are frequently among the leading imports into countries of this group, which require steel for railways, for construction and for the innumerable needs of an awakening economic life. Representative territories of this type are the Philippine Islands, the Dutch East Indies, and to a large degree, the Argentine Republic,

A third group is made up of countries which are themselves large producers. In the years preceding the war, Great Britain found better sale for her iron and steel in the United States than in many non-steel-producing countries. Germany usually bought more iron and steel products from her competitor, Great Britain, than did British South Africa. The United States, while normally selling both crude and manufactured steel to the United Kingdom, buys British specialties also.

International trade in iron and steel can be discussed statistically only within the limits imposed by official statistics themselves. Not all classes of commodities are reported quantitatively and statements of values for imports and exports are rendered useless for comparative purposes by the abnormal fluctuations of prices since 1914. Pig iron, raw steel and finished iron and steel are reported by quantities in statistics of most countries, while frequently values alone are available for machinery, tools, implements, certain hardware and other manufactures. For this reason it is impracticable to discuss international trade in machinery and other manufactures, although much of the output of the steel industry is exported in such forms as sugar-mill machinery for Cuba, agricultural implements for Australia, and locomotives for South America.

The American industry has heretofore exported a smaller share of its output than have the industries of Germany and Great Britain. The exact ratio between exports and total production is difficult to determine. It is estimated, however, that prior to the war American exports averaged about 8 per cent. of the total pig iron production, and practically the same per cent. of total steel output. Dur-

ing the war the proportion of exports to total pig iron and steel output rose somewhat. In 1919, exports were estimated at about 14 per cent. of all pig iron produced, and in 1920 and 1921, 13 per cent.

It is a commonplace that Great Britain lives by foreign trade. The imported food supply and raw materials for manufacturing are paid for largely in textiles, iron and steel and coal. In 1913 the volume of exports of iron and steel of all classes was about 50 per cent. of the weight of pig iron produced. Belgian dependence on foreign markets was still greater as the country's exports in 1913 were estimated at nearly 70 per cent. of production. Germany's exports absorbed over 35 per cent. of production in 1913. France had a smaller proportion of exports, around 20 per cent., in the same year.

Raw and semi-manufactured products form a smaller total in foreign trade than finished iron and steel, as the former can be utilized only by countries able to carry out all the succeeding manufacturing processes. The larger share of the trade is in finished iron and steel, especially rails, bridge and structural iron, plates and sheets, pipes and fittings, bars and rods, etc. Under abnormal conditions during the war, large shipments of steel ingots, billets and blooms were supplied by the United States to England, France and Italy for munitions, but normally exports of this class form a relatively small total.

In response to war demands exports of steel from the United States rose to unprecedented volume and for two years after the armistice remained above the pre-war level, but in 1921 steel exports reflected the world-wide trade depression. France alone of all the European countries exported more iron and steel after the war (1920 and 1921)

than in 1913. British exports from 1914 to 1921 were much smaller than in 1913, German foreign trade was improving to some extent in 1920 and 1921, while at the same time Belgian trade reached about half the volume of exports maintained before the war. Although the foreign trade statistics of the five countries do not afford an exact basis of comparison, the following table, showing total exports of iron and steel (not including machinery) so far as they are reported by weight, will serve as an indication of the position of each country in 1913 and from 1919 to 1921.

TABLE H—EXPORTS OF IRON AND STEEL BY PRINCIPAL COUNTRIES

	1913	1919	1920	1921
		(in tons[1])		
United States	3,018,500	4,399,699	4,935,136	2,213,378
United Kingdom	4,933,704	2,232,844	3,251,225	1,700,407
Germany	6,497,262	[2]	1,750,601	[3]1,631,948
France	1,144,946	397,394	1,385,898	2,266,633
Belgium	1,722,720	176,770	923,063	995,836

[1]United States and United Kingdom, gross tons of 2,240 pounds; other countries, metric tons of 2,204.6 pounds.
[2]Not available.
[3]Figures for May to December only; other months not available.

The increase in American exports during the war years was due primarily to the furnishing of materials for munitions and supplies to the belligerent countries, and secondarily, to expansion of trade with Far Eastern and South American markets. To a limited extent American iron and steel supplied the deficiency of European goods in those markets. The contraction of British exports seriously affected many of Great Britain's foreign markets and up to the close of 1921 no great progress had been made in regaining the pre-war volume of trade. A de-

termined effort was made to maintain the supplies usually sent to British dominions, but nevertheless, exports to British possessions fell from an average of about 1,950,000 tons in the five years 1909–13 to about 900,000 tons in 1914–18. The change in distribution of British exports from 1909 to 1920 (the latest year for which exports by countries are available) is shown in table I, and the pre-war and post-war distribution of representative products in American export trade is given in table J.

International trade is influenced primarily by prices, secondarily by other factors, such as terms of sale, shipping connections etc. Since the excessive depreciation of Continental currencies makes comparisons involving French and German prices worthless, the following table includes only prices of American and British products, involving the smaller degree of decline in sterling exchange since the war. The prices quoted are for sales in the domestic market in each country, as no standard and uniform quotations for prices in export trade are available.

The world was making and using steel in 1913 at the rate of about 75,000,000 tons a year. In the four years which followed, industries strained to produce their maximum output, much of which was reduced to scrap and rust. In 1919 and 1920 production amounted to less than 70,000,000 tons and in 1921 declined to about 40,000,000 tons. This indicates not so much reduced needs as reduced purchasing power and world-wide depression which rendered normal replacements and extensions impossible.

It is probable that there has not been over-expansion of productive capacity since 1913 in relation to the world's normal requirements for iron and steel. The temporary

TABLE I—EXPORTS BY COUNTRIES OF IRON AND STEEL AND THEIR MANUFACTURES FROM THE UNITED KINGDOM[1]

Country	1909–13 (5-yr. aver.)	1914	1915	1916	1917	1918	1919	1920
				(in gross tons)				
Russia	81,470	79,194	30,188	35,328	36,766	1	7,980	16,850
Sweden	100,822	112,691	95,847	38,437	8,074	1,297	35,999	59,343
Germany	222,597	115,166	....	....	....	....	2,534	27,265
Netherlands	150,848	106,724	70,423	44,871	11,542	702	155,937	137,042
Belgium	115,208	63,568	12,652	144	1	....	113,704	246,416
France	177,748	156,802	782,724	1,667,499	1,505,072	936,549	346,440	238,651
Italy	172,544	117,979	158,952	173,581	208,665	173,259	116,155	127,423
Japan	245,277	148,307	129,934	132,808	18,317	18,590	132,823	169,081
United States	199,478	131,370	75,356	91,066	68,288	42,787	54,387	82,770
Brazil	120,409	42,381	33,242	16,152	5,069	2,676	15,690	46,425
Argentina	363,445	254,803	139,779	66,443	43,063	30,062	49,815	116,555
Union of South Africa	196,389	191,204	135,312	76,586	38,469	29,677	94,823	160,514
British India	646,764	808,842	463,090	231,212	119,164	93,127	312,648	659,429
Australia	487,721	551,820	357,079	189,750	52,771	66,039	146,390	193,800
New Zealand	142,993	121,039	101,219	51,589	14,046	12,860	56,881	70,435
Canada	247,087	86,415	33,315	22,498	17,753	25,360	12,908	30,780
Other countries	940,389	795,848	577,871	456,660	180,970	175,117	577,730	868,446
Total	4,611,189	3,884,153	3,196,983	3,294,624	2,328,030	1,608,103	2,232,844	3,251,225

[1] Included are pig iron; ferro-alloys; iron bars, castings and forgings; other wrought iron; steel ingots, blooms, billets, slabs, bars, rods, castings and forgings; plates and sheets; shapes and structural material; rails; railway materials; wheels, axles and tires; tubes, pipes and fittings; hoops and strips; bolts, nuts, nails, rivets and screws; anchors, grapnels and cables; chains; wire and wire manufactures; bedsteads; and miscellaneous manufactures of iron and steel.

TABLE J—EXPORTS BY COUNTRIES OF CERTAIN STEEL PRODUCTS FROM THE UNITED STATES

Country	Rails: 1910–14[1] (5-yr. average)	Rails: 1919	Rails: 1920	Rails: 1921	Bars and Rods[2]: 1910–14[1] (5-yr. average)	Bars and Rods[2]: 1919	Bars and Rods[2]: 1920	Bars and Rods[2]: 1921
		(in gross tons)				(in gross tons)		
France	......	141,261	11,950	721	45	80,420	2,709	1,067
Italy	40	23,040	....	[3]	......	10,070	2,160	1,048
United Kingdom	1,535	9,161	14,859	14,384	15,220	68,232	60,708	13,158
Canada	87,830	25,580	15,658	23,032	85,730	65,923	121,645	44,270
Mexico	37,458	10,670	8,801	5,006	1,230	1,729	2,813	4,203
Cuba	33,972	57,281	114,371	19,366	7,556	13,076	33,426	11,652
Argentina	42,773	855	17,107	11,182	662	15,017	36,680	11,224
Brazil	34,795	8,816	50,982	21,690	884	10,351	16,877	6,035
Chile	17,140	11,146	8,135	6,641	4,228	8,953	6,855	5,994
China	6,033	23,320	13,766	45,848	888	20,593	62,422	10,660
British India	21	4,279	4,918	3,411	921	27,069	21,627	16,184
Dutch East Indies	85	29,536	37,719	32,364	61	11,045	16,630	7,223
Japan	31,552	152,997	135,873	42,239	6,503	146,821	176,507	23,908
Russia in Asia	......	11,115	....	[3]	....	679	196	....
Australia	40,790	23	237	[3]	4,496	4,360	2,399	2,919
Philippine Islands	9,366	13,997	21,938	6,649	6,829	8,945	19,888	7,909
British South Africa	1,835	23,817	22,482	1,410	964	2,849	1,432	411
Other countries	48,717	105,549	115,832	88,164	11,704	58,079	44,077	20,598
Total	393,942	652,443	594,628	322,107	147,921	554,211	629,051	188,463

[1]Fiscal years.
[2]Not including wire rods.
[3]Not separately reported.

Table J (cont.)—Exports by Countries of Certain Steel Products from the United States

Country	Structural Iron and Steel 1910–14[1] (5-yr. average)	1919	1920	1921	Plates and Sheets[2] 1910–14[1] (5-yr. average)	1919	1920	1921
		(in gross tons)				(in gross tons)		
France	306	79,665	13,872	12,721	9	85,484	34,221	34,966
Italy	124	19,185	6,758	14,019	210	65,918	38,306	24,885
United Kingdom	50	1,399	10,187	916	8,485	36,603	150,085	52,314
Canada	143,288	99,032	137,930	59,782	194,953	239,640	270,743	140,181
Mexico	11,919	3,906	11,238	18,288	4,501	7,831	11,517	9,257
Cuba	12,895	23,600	47,703	23,872	4,783	8,530	18,631	5,325
Argentina	4,648	13,265	32,320	4,787	2,359	11,783	23,777	4,270
Brazil	5,025	6,201	8,933	5,690	623	7,316	8,828	2,425
Chile	4,224	9,917	2,489	8,754	11,356	5,500	5,911	3,160
China	908	6,033	6,037	4,479	552	24,766	23,349	5,787
British India	1,657	5,365	39,840	36,364	1,371	10,219	22,268	5,239
Dutch East Indies	150	12,030	12,159	13,996	16	13,866	10,946	6,801
Japan	10,503	49,920	89,839	48,827	10,225	281,802	273,452	158,664
Russia in Asia	392	55	....	[3]	....	185	10	[3]
Australia	7,249	3,216	4,020	5,784	9,837	13,016	20,398	24,512
Philippine Islands	3,318	5,062	6,330	1,869	1,667	5,057	2,856	4,201
British South Africa	908	818	313	[3]	1,360	3,503	5,930	1,053
Other countries	34,593	22,118	63,665	36,874	12,176	66,460	168,975	46,261
Total	242,157	360,787	493,633	297,022	264,483	887,479	1,090,203	529,301

[1] Fiscal years.
[2] Not including tinplate, galvanized sheets, and ship and tank plates punched and shaped.
[3] Not separately reported.

TABLE K—COMPARATIVE PRICES OF IRON AND STEEL FOR DOMESTIC CONSUMPTION IN THE UNITED KINGDOM AND THE UNITED STATES

Year and month[1]	Bessemer Pig: British Hematite, West Coast Mixed Nos. £	s.	d.	Bessemer Pig: American, Pittsburgh	Basic Pig: British, Cleveland £	s.	d.	Basic Pig: American Valley Furnace	Billets: British, Soft £	s.	d.	Billets: American Open Hearth, Pittsburgh	Rails (Heavy): British £	s.	d.	Rails (Heavy): American Open Hearth, at mill
1919																
January	6	13	9	$33.60	5	0	0	$30.00	10	7	6	$43.50	10	17	6	$67.00
April	6	7	6	29.35	5	0	0	25.75	12	5	0	38.50	13	7	6	47.00
July	9	12	6	29.35	8	5	0	25.75	13	17	6	38.50	16	10	0	47.00
October	10	4	6	29.35	8	5	0	25.75	15	0	0	38.50	16	10	0	47.00
1920																
January	11	4	6	40.40	9	0	0	37.00	18	0	0	45.00	18	15	0	47.00
April	13	15	0	43.40	10	10	0	42.00	24	10	0	65.00	21	0	0	57.00
July	14	15	0	47.40	11	7	6	46.00	25	0	0	65.00	23	0	0	60.00
October	14	15	0	50.46	11	15	0	46.00	20	10	0	55.00	25	0	0	57.00
1921[2]																
January	13	15	0	33.96	11	0	0	30.00	15	10	0	43.50	25	0	0	47.00
February	11	0	0	28.96	9	0	0	27.00	14	0	0	43.50	21	0	0	47.00
March	9	0	0	28.96	7	0	0	25.00	13	10	0	38.50	18	0	0	47.00
April	9	0	0	26.96	6	0	0	23.00	13	10	0	37.00	18	0	0	47.00
May	9	0	0	25.96	6	0	0	22.00	13	0	0	37.00	15	0	0	47.00
June	8	0	0	24.96	6	0	0	21.50	11	10	0	37.00	15	0	0	47.00
July	8	0	0	22.96	6	0	0	19.00	10	10	0	33.00	14	0	0	47.00
August	8	0	0	21.96	7	7	6	18.00	9	10	0	30.00	14	0	0	47.00
September	7	0	0	21.96	7	7	6	19.00	7	10	0	30.00	14	0	0	47.00
October	6	8	6	21.96	7	7	6	19.25	7	10	0	30.00	12	10	0	47.00
November	5	18	6	21.96		[3]		19.00	7	5	0	30.00	10	10	0	40.00
December	5	13	6	21.96		[3]		18.75	7	5	0	29.00	10	0	0	40.00
1922																
January	5	10	0	21.46	5	0	0	18.25	7	0	0	28.00	9	10	0	40.00
February	4	18	6	21.46	4	10	0	17.75	7	0	0	28.00	9	10	0	40.00
March	4	18	6	21.46	4	10	0	18.00	6	15	0	28.00	9	10	0	40.00
April	4	18	6	22.96	4	10	0	19.50	7	0	0	29.50	9	10	0	40.00
May		[4]		26.96	4	0	0	25.00	7	0	0	34.00	9	10	0	40.00
June		[4]		26.96	4	0	0	25.00	7	5	0	35.00	9	10	0	40.00

[1] Prices shown are for the fifteenth of the month or the nearest available date.

[2] For British products, figures quoted are official basis prices. Because of conditions prevailing in 1921 little, if any, business was done at those figures.

[3] No quotation.

[4] Not available.

advantage in the international market enjoyed by some countries as a result of the exchange factor is gradually disappearing, and competition will again be on the basis of cost of production and quality of service to foreign customers.

LUMBER

THE forest lands of the world, according to the latest estimates, amount to about 4,000,000,000 acres, or 24 per cent. of the total land area. This does not include the forests of China, Korea, and the larger part of South America and Africa, for which even fair estimates are lacking. All figures for forest lands, however, are more or less approximations. For Europe only can data be regarded as fairly accurate; but this accuracy does not extend to Russian figures. Table A shows as far as data are available the location of the main forest areas of the world. Political designations are those of 1910.

TIMBER CLASSIFICATION

Mere acreage, however, is not the sole determining factor of a country's position as to timber supply, for all woods are not equally workable or serviceable. Thus, although large areas of Africa, South America and Australia are under heavy tropical forests, they produce mainly hard, dense, heavy woods unsuitable as lumber for general purposes and suited only for limited specialized uses.

Trees from which timber of commercial value is obtained are of two broad classes: coniferous or cone-bearing trees, and hardwood or broadleaf trees. The former comprise what are ordinarily called softwoods, the principal species being the pines, spruce, fir, hemlock, larch, tamarack, cedar, cypress and redwood. They may invariably be

TABLE A—DISTRIBUTION OF FOREST AREAS OF THE WORLD IN 1910

Country	Total forest area (in millions of acres)
EUROPE	
Austria-Hungary	53
Finland	53
France	24
Germany	35
Norway	17
Russia in Europe	465
Sweden	49
Other countries	54
Total Europe	*750*
ASIA	
India	149
Japan	58
Philippines	49
Russia in Asia	348
Other countries	7
Total Asia	*611*
AUSTRALIA	*133*
AFRICA	
Central Africa	224
Madagascar	25
Other countries	10
Total Africa	*259*
AMERICA	
Alaska	107
Canada	799
Mexico	25
South America (tropical)	528
United States	545
West Indies	43
Total America	*2,047*
Grand total	3,800

recognized by their needle leaves, resinous bark and cones, and in almost every case are evergreens. They are usually soft and light, from which qualities they derive the name softwoods. The broadleaf trees are the hardwoods, deriving the name from the fact that as a class they are

heavier and harder than the softwoods, although there is a certain degree of overlapping of these qualities between the two groups. Poplar and basswood, for instance, are neither heavy nor hard, but are termed hardwoods.

FOREST RESOURCES OF LEADING COUNTRIES

Russia in Europe and in Asia contains almost half the world's timber stands of commercial species. So far, however, the Russian lumber industry has developed in European Russia, as there has been only an insignificant exploitation of the forests of Siberia. Although the estimated forest area of European Russia is nearly 500,000,000 acres, the timber area is somewhat less than 300,000,000 acres, because of reductions that must be made for waste land, swamps, etc. Russia possesses vast coniferous forests and also large forests of hardwoods, mainly oak, poplar, elm and ash. At the beginning of the war the Russian lumber industry had little more than started, the total cut of its sawmills being about eleven billion feet, compared with an American cut at that time of over forty billion. However, there was a large local lumber business that did not go through the sawmills, and which thus did not appear in the figures for the Russian cut.

Before the war Austria-Hungary was one of the most important lumber-producing countries in the world. The annual cut of its forests, which were nearly all under careful management, amounted to about 2,827,000,000 cubic feet. The political dissolution of the empire, however, and the economic disorganization resulting have demoralized the industry, which will probably not be able to reach its pre-war efficiency for a considerable time.

It has been estimated that the total area of commer-

cially valuable timber in Canada lies somewhere between 200,000,000 and 300,000,000 acres and contains a stand of from 500,000,000,000 to 800,000,000,000 board feet. This has been cut into lumber during the last ten years at an average rate of about 4,000,000,000 feet board measure per annum, with smaller cuts for the preceding years. Table B shows the lumber production in Canada from 1908 to 1920.

TABLE B—LUMBER PRODUCTION IN CANADA, 1908 TO 1920

Year	M board feet
1908	3,348,176
1909	3,814,942
1910	4,901,649
1911	4,918,202
1912	4,389,723
1913	3,816,642
1914	3,946,254
1915	3,842,676
1916	3,490,550
1917	4,151,703
1918	3,886,631
1919	3,830,831
1920	4,302,625

TABLE C—LUMBER CUT OF CANADA BY SPECIES

Species	1913	1918	1919	1920
		(M board feet)		
Spruce	1,274,216	1,142,777	1,335,044	1,490,098
Douglas fir	793,143	715,812	817,844	901,915
White pine	678,330	808,652	479,937	641,687
Hemlock	306,342	273,356	234,785	319,592
Red pine	144,320	102,105	89,198	96,253
Cedar	101,053	130,228	98,808	197,004
Tamarack	96,325	77,135	16,490	73,891
Balsam fir	64,957	94,774	140,834	132,390
Hardwoods	263,613	201,667	196,066	254,883
All other	94,343	340,125	421,825	194,912
Total	3,816,642	3,886,631	3,830,831	4,302,625

Of the softwoods, spruce, Douglas fir, white pine, hemlock, cedar and balsam fir, which predominate in Canada's

timber, spruce is the most important and is the chief source for the manufacture of wood pulp. Table C gives the lumber cut of Canada by species for 1913, 1918, 1919 and 1920.

British Columbia, Ontario and Quebec have the greatest quantities of standing timber, the central provinces being largely treeless prairies. Table D shows Canada's lumber cut by provinces for 1913 and from 1918 to 1920.

TABLE D—LUMBER CUT OF CANADA BY PROVINCES

Province	1913	1918	1919	1920
		(M board feet)		
British Columbia	1,173,647	1,157,636	1,175,151	1,443,270
Ontario	1,101,066	1,110,062	940,199	992,901
Quebec	630,346	841,084	884,612	916,422
New Brunswick	399,247	442,625	497,593	515,785
Nova Scotia	274,722	176,332	225,074	273,987
Saskatchewan	114,800	75,835	42,452	54,371
Manitoba	71,961	54,047	30,353	58,419
Alberta	44,462	22,388	26,173	41,229
Prince Edward Island	6,391	6,393	8,971	6,241
Yukon	....	229	253	....
Total	3,816,642	3,886,631	3,830,831	4,302,625

The United States originally possessed approximately 822,000,000 acres of timberland estimated to contain 5,200,000,000,000 board feet of saw timber, of which about 463,000,000 acres containing 2,215,000,000,000 feet remain. Of the amount removed about one-third has been lumbered, one-third destroyed by forest fires and one-third wasted. The remaining virgin stands consist chiefly of various species of hardwoods in the Central and Southern hardwood regions, the yellow pine along the South Atlantic and Gulf coasts, and the Douglas fir, spruce and cedar of the far Northwest, with smaller stands of redwood, California sugar and white pine, western yellow pine and

Idaho white pine in the Inland Empire region, the white pine in northern Minnesota and Wisconsin and spruce in Maine. Table E on page 96 shows the distribution of American standing timber by species and regions.

The American lumber cut, which is several times that of any other country, reached its maximum, 46,000,000,000 feet, in 1906 and 1907. The total production of wood for all purposes including fire wood, pulp wood, etc. is known to be very much larger than the lumber cut, but statistics are not available. Table F shows the estimated total cut of lumber in the United States from 1904 to 1920.

TABLE F—LUMBER PRODUCTION IN THE UNITED STATES, 1904 to 1920

Year	M board feet
1904	43,000,000
1905	43,500,000
1906	46,000,000
1907	46,000,000
1908	42,000,000
1909	44,500,000
1910	44,500,000
1911	43,000,000
1912	45,000,000
1913	44,000,000
1914	40,500,000
1915	38,000,000
1916	40,000,000
1917	36,000,000
1918	32,000,000
1919	34,550,000
1920	33,799,000

HISTORY OF INDUSTRY IN THE UNITED STATES

One hundred years ago lumbering in the United States was confined to small sawmills on the coast and river courses of the East. Except for a small export trade the markets supplied were entirely local. Transportation was almost entirely by waterways. Although various "up-

TABLE E—STAND OF SAW TIMBER IN THE UNITED STATES BY SPECIES AND REGIONS AS OF JUNE 1, 1920

(in millions of board feet, lumber tally)

Species	New England	Middle Atlantic	Lake	Central	South Atlantic and East Gulf	Lower Mississippi	Rocky Mountain	Pacific Coast	Total
Eastern hardwoods									
Oak	1,510	5,500	8,301	64,712	27,889	49,460	......	....	157,372
Birch, beech and maple	8,143	16,897	36,076	20,505	4,522	4,641	......	....	90,784
Red gum	......	176	......	3,728	13,400	26,918	......	....	44,222
Chestnut	960	3,754	......	7,989	6,616	......	......	......	19,319
Hickory	40	412	187	6,791	3,183	5,171	......	....	15,784
Cottonwood and aspen	374	13	999	2,131	1,340	5,967	......	....	10,824
Ash	215	513	1,893	2,929	1,256	3,182	......	....	9,988
Yellow poplar	.....	126	7	5,193	4,020	265	......	....	9,611
Other	77	2,113	21,887	19,174	21,524	36,996	......	....	101,771
Total	11,319	29,504	69,350	133,152	83,750	132,600	......	....	459,675
Eastern softwoods									
Southern yellow pine	.....	.....	....	365	121,442	135,884	......	....	257,691
Hemlock	1,804	5,036	18,301	3,910	1,845	......	......	....	30,896
Spruce and fir	23,971	2,948	3,772	......	881	......	......	....	31,572
Cypress	.....	.....	....	......	11,208	11,713	......	....	22,921
White and Norway pine	9,816	4,037	8,000	515	1,089	......	......	....	23,457
Other	2,889	[1]3,332	10,687	[1]6,528	362	711	......	....	24,509
Total	38,480	15,353	40,760	11,318	136,827	148,308	......	....	391,046
Western softwoods									
Douglas fir	......	......	....	......	....	......	36,934	558,571	595,505
Western yellow pine and Jeffrey pine	......	......	....	......	....	......	66,125	183,453	249,578
Western hemlock	......	......	....	......	....	......	1,092	94,000	95,092
True firs	......	......	....	......	....	......	8,870	82,479	91,349
Redwood	......	......	....	......	....	......	....	72,208	72,208
Western white pine and sugar pine	......	......	....	......	....	......	18,586	38,485	57,071
Western red cedar	......	......	....	......	....	......	4,348	49,000	53,348
Lodgepole pine	......	......	....	......	....	......	39,353	4,566	43,919
Spruce	......	......	....	......	....	......	26,467	13,355	39,822
Other	......	......	....	......	....	......	21,366	44,914	66,280
Total	.....	.....	......	......	......	......	223,141	1,141,031	1,364,172
Grand total	49,799	44,857	110,110	144,470	220,577	280,908	223,141	1,141,031	2,214, 893

[1]Includes small amounts of various species of yellow pine.

and-down" sawmills were established on the Penobscot, Hudson and Delaware rivers early in the nineteenth century, the average sawmill up to 1880 was a small affair.

As the Middle West became settled and railway transportation developed, the center of lumber manufacture shifted to the region of the Great Lakes. The famous white pine industry of the lake states began about 1850 and did not decline until the end of the eighties. The golden age of northern white pine was reached in 1870 in the State of Michigan. The lake states industry differed from the former industry of the eastern coast in being organized and capitalized on a large scale. It catered principally to the eastern and central markets.

As the white pine industry declined toward the end of the century, owing to depletion of the virgin forest, the lumber market was diverted to pine from the southern states. In the eighties and early nineties southern pine first extended beyond local consumption. Owing to cooperation from the new railroads in the South, it became possible to supply the eastern and central markets of the United States with southern pine lumber. Central, eastern and southern parts of the United States depend mainly on the southern forests for their lumber, but in the course of a few years the southern pine industry will be able to supply only local consumption from its bits of virgin timber and second growth. The eastern and lake forests have had a similar history.

The lumber industry of the Pacific coast, which has come to be important since 1900, is the large American industry of the future. Of the total available timber supply, over 50 per cent. is estimated to be in the Pacific Northwest.

Douglas fir is becoming important on the Atlantic coast and is sold extensively in the central market. The territory from the Pacific coast eastward to the Missouri River and southward to western Kansas is now almost entirely dependent on the west coast mills for its lumber supply. The tendency is to extend eastward and southward. However, for some time to come southern yellow pine will predominate in the central and eastern markets.

DEVELOPMENT IN FOREIGN COUNTRIES

Because of their vast timber resources Russia, Canada and the United States have been unusually wasteful of their forests. The dense population of the western European countries, on the other hand, with the consequent reduction of forest areas, has made efficient forestry necessary there. In this regard Germany stood first, closely followed by France, Austria-Hungary, Denmark, Belgium, Switzerland, Norway, Sweden and Finland.

The forest resources and the lumber industry of Norway, Sweden and Finland are of great importance particularly from the standpoint of the international market. Although the lumber is not naturally of such good quality as that from the United States and Canada, the methods of manufacturing are superior. Baltic products are generally better sawed and planed. The material is carefully inspected and graded, is ordinarily seasoned for six months before shipment, and is usually branded. In Sweden, as the prosperity of the country is considered to be contingent to a large degree upon the existence of the forests, stringent laws against the depletion of timberlands have been enacted. Extreme care is taken in the sawmills to prevent the waste of even the smallest piece of lumber

and close coöperation exists among producers. Swedish wood production is reported in cubic feet, and under normal pre-war conditions was about 950,000,000 cubic feet per year. Norway annually cuts about 345,000,000 cubic feet. Heavy inroads were made during the war on the timber stands and available stocks of lumber of Norway and Sweden by the large demands of the warring countries. For the immediate future in European international trade the Finnish lumber industry is now the most important. Finnish forests are composed almost exclusively of pine, spruce, birch and to some extent alder, the most valuable species being pine. Forestry is conducted on a modern, scientific basis. Although less than 50 per cent. of the timber is government owned, the timber stands cannot be depleted, and cutting is done gradually so that the new timber grown annually is always at least equal to the annual cut.

INTERNATIONAL TRADE

With regard to trade in lumber, countries may be divided into five classes. First are those countries such as Russia, Canada and the United States which export more than they import. Second are those countries which, with a highly developed forest management and important forest possessions, themselves produce much wood but none the less have to import foreign wood to meet the requirements of their industries. Such countries were the German Empire before the war, France, Switzerland and Belgium. The third group comprises countries in which forest management plays but a small part on account of the small forest area, representative countries being Great Britain, the Netherlands, Denmark and South Africa. Fourth

are countries with only slightly developed forest management and little wood consumption, such as Italy, Spain, Portugal and Greece. The fifth group comprises countries with relatively large forest areas which are in large part not yet fully developed, are unequally distributed or are poorly managed. In this group, for example, are Serbia, Bulgaria, the South American countries and the West Indies.

Countries which import their main timber and lumber supply may export small quantities of wood valued for special uses, while those countries on which the world depends for its wood usually import kinds not produced by their own forests. In the case of the United States, however, as more than 80 per cent. of the lumber imports are from Canada, this trade does not differ essentially from domestic business. Importations from countries other than Canada, though not large in volume, are high in value, and consist chiefly of fine cabinet woods not found in Canada or the United States. Of these woods mahogany comes principally from Central America, Mexico and British West Africa and cedar from Cuba, Mexico and Brazil. Briar wood is imported from France, Italy and French Africa.

The chief lumber-exporting countries before the war were Russia, including Finland, Austria-Hungary, Sweden, Norway, Canada and the United States. Table G shows approximate net exports from the leading exporting countries for 1913. Because of the political realignments in Europe following the war, later comparable data are not available.

Before the war Russia was the principal source of imported lumber for western European countries. Sixty-

TABLE G—NET EXPORTS OF LUMBER FROM THE CHIEF EXPORTING COUNTRIES IN 1913

Country	Net exports (in millions of feet)
Russia	7,500
Austria-Hungary	3,800
Sweden	3,300
Finland	2,600
Canada	2,200
United States	1,700

five per cent. of the output was for export, the majority of the sawmills being in the port cities. In 1913 Russia exported 7,500,000,000 feet of lumber, one-third of which went to Germany, one-third to the United Kingdom, one-sixth to Holland and the rest mainly to other European countries. According to recent reports, however, only a small fraction of the domestic demand at present is being supplied and it will probably be many years before Russia can regain any substantial part of her former importance in the world's markets.

Austria-Hungary before the war was second only to Russia as an exporter of lumber. Its exports showed a steady increase, but even if the disorganization resulting from the war had not occurred, the increase would probably not have continued for long; annual cut was greater than annual growth, and owing to the country's forestry policy its productivity was capable of only limited increase. Of exports from Austria-Hungary before the war, one-half went to Germany and about one-fourth to Italy.

Of Sweden's exports of more than 3,000,000,000 feet per year, the United Kingdom has been accustomed to take nearly one-half, the remainder being distributed among other western European countries. Exports from Finland have been distributed in about the same way.

More than two-thirds of Canadian exports go to the United States, and most of the remainder is sent to the United Kingdom.

The other regions of the world are lacking in lumber-cutting development, and do not contain the common softwoods, which are the chief staple timber product of international trade. Central and South American countries now depend upon the United States, Canada and Sweden for most of their softwoods and are not likely to be factors as exporters for many years to come, if ever. Africa does not yet supply its own needs. China is becoming an increasingly large importer. Japan does little more than supply its own requirements. Australia and New Zealand are now forced to import lumber from the United States and Canada.

EXPORTS FROM THE UNITED STATES

Though American lumber exports have a wider distribution through the world than the lumber of any other country, a comparatively small proportion of United States lumber has been exported. The average annual gross exports of lumber in the five years just preceding the war amounted to 2,221,000,000 board feet, in comparison with the total average cut during these years of 44,200,000,000 feet. Though Canada and the United Kingdom are the largest single customers, it is the heavy importation of Canadian lumber into the United States which reduces the American gross timber and lumber prewar export figure of nearly 4,000,000,000 feet to net exports of less than 2,000,000,000 feet. Table H shows American exports of short lumber, i.e., boards, planks, scantlings, etc., for the average of the three fiscal years

from July 1, 1911, to June 30, 1914, and for the calendar years 1919, 1920 and 1921.

TABLE H—EXPORTS OF SAWED LUMBER FROM THE UNITED STATES BY SPECIES FOR THE FISCAL YEARS ENDING JUNE 30, 1912 TO 1914, AND CALENDAR YEARS 1919, 1920 AND 1921

Species	1912–14[1] (3-yr. average)	1919	1920	1921
		(M board feet)		
Pine:				
White	[2]46,580	24,236	38,732	14,793
Yellow:				
Pitch (longleaf)	853,445	437,773	637,152	432,736
Shortleaf	37,325	19,884	16,167	3,905
All other	208,857	69,865	104,778	77,410
Total pine	*1,146,207*	*551,758*	*796,829*	*528,844*
Fir	658,298	301,144	451,223	455,233
Oak	247,143	157,937	105,141	68,600
Gum	71,550	72,330	27,266	27,634
Redwood	[2]59,529	34,211	45,006	15,892
Poplar	30,539	35,645	19,224	9,702
Spruce	18,516	21,685	21,862	7,195
Cypress	[2]14,443	14,865	10,952	4,993
All other	214,719	121,635	73,855	86,724
Total	2,460,944	1,311,210	1,551,358	1,204,817

[1]Does not include joists and scantlings.
[2]Two-year average.

Yellow pine, fir and oak constitute together about four-fifths of the total exports. Southern yellow pine, consisting chiefly of longleaf pine but including also shortleaf, loblolly, rosemary, slash and other yellow pines, is exported principally to western Europe, the West Indies, the east coast of South America and eastern Canada. Douglas fir goes mainly to Australia, South Africa, Mexico, the west coast of South and Central America and the Orient. Oak is sent to all parts of the world, particularly to western Europe and Canada.

Although Russia and Siberia probably will prove even-

tually to be the keenest competitors of the American lumber industry, the Scandinavian countries, including Finland, are the only countries besides Canada which can at present offer much competition to the United States in the international market. The principal advantages of the Scandinavian and Finnish exporters of lumber are superior shipping facilities through native-owned tonnage, efficient marketing systems, coöperation among exporters, close connections between exporters and importers, proximity to the principal markets, elimination of many middlemen and established reputation. Canada will always be a competitor of the United States as a lumber exporter, but on account of its smaller production cannot export on as large a scale as the United States.

For the United States, however, to increase its exports of southern yellow pine before the pine land best suited to growing this timber is placed on a permanent producing basis is a policy open to question. There is an increasing demand on the softwood forests of the Pacific Northwest as the end of the present stand of southern yellow pine and the eastern white pine comes in sight, and if there is much further increase of United States exports of Douglas fir, western white pine, sugar pine, western yellow pine and other softwoods it will seriously diminish the future domestic supply of raw materials. Likewise, in the hardwood industry there is danger of exporting more than the surplus over and above domestic needs. Although this country possesses more valuable hardwood timber than any other temperate region in the world and, with the possible exception of the Carpathian region of eastern Europe, the largest temperate zone supply, yet the exportation of raw material for European furniture factories and

other wood-using industries might in the future cause American industry to go without or to pay excessive prices.

At present the timber supply of the world outside of the tropics is being used more rapidly than it is being renewed by growth. In the United States the annual timber growth is about one-third of the annual cut and the oncoming growth is ordinarily of inferior species and grade. On this account the lumber export business of the United States cannot be permanently enlarged without detriment to the national welfare until provision has been made which will secure a renewal of the forests of this country by the practice of scientific forestry. Heavy export sales of United States timber would mean that this nation, which is the largest wood-using country in the world, would be obliged to secure its timber supplies in a world market of increasing scarcity. If such a situation developed, a drastic readjustment would be required, for the majority of the dwellings and farm buildings in this country are made of wood and more than half the total domestic consumption is used for construction. By practical forestry methods, however, it would be possible to produce in the United States in the next half century an annual cut of many billion feet of lumber for export after meeting the demand for domestic needs without depleting the standing timber supply.

ORGANIZATION OF UNITED STATES LUMBER INDUSTRY

In the past the lumber industry of the United States has been characterized by violent and destructive competition between different regions and between different mills in the same region, and speculative manipulation of timber

ownership produced sudden fluctuations in both output and price. Lack of sensitive adjustment of supply to demand has developed the lumber industry to such an extent that it is equipped to produce substantially in excess of normal consumption.

The organization of the lumber industry comprises five successive functions which are carried out in great diversity of combination by industrial units. These functions are the ownership or control of standing timber, logging, manufacturing of lumber, wholesale distribution and retail distribution. The most common industrial unit combines the first three functions, and often undertakes the distribution of its own lumber to the retailer, or even to the ultimate consumer. The lumber manufacturer ordinarily owns his timber. There has been a recent tendency toward consolidation of holdings in large tracts, which points to central control of the industry. Owing to the policy of the Government in selling its timberlands, there has been, since 1870, a vast speculative purchase of timberland far in advance of any possible use of the timber. Hence, it is generally recognized that the big profit in the Northwest, and also to a great degree in the South, has not been in lumber manufacturing but in the increase in the value of timberlands.

In certain regions logging, including the felling of timber and cutting it into suitable lengths for the sawmills and delivery of the logs by rail and water, has been a distinct industry. However, the majority of lumber manufacturers have their own logging crews. In the early period of lumbering, there were separate companies of river "drivers."

The technical processes of sawing and marketing lumber

in the United States have been highly developed in the last fifty years. River drives have been superseded in the southern and lake states, principally through temporary logging railroads or tap lines built into the woods. The most efficient modern methods have been introduced in the Pacific Northwest, the evolution being due largely to the increasing inaccessibility of timber.

In contrast to the enormous mills cutting virgin timber in the Northwest and other parts of the country are the small mills which take over the lumber industry of a region after the original timber has been largely cut away. The result is a great diversity in the size and character of American lumber mills. There is every variety and style of sawmill, from the little stationary plant with sash saw, worked up and down by water power, to the large plant with its complement of main and secondary kilns and planers, which may turn out 250,000 feet of lumber every day. Mills classified as having an output of from 50,000 to 499,000 feet a year comprise about two-thirds of the total mills of the country. However, the largest mills, those having an output of 10,000,000 feet or more a year, though they constitute only about 4 per cent. of the total number of mills, now produce about 60 per cent. of the country's lumber. The proportion both of the largest sized mills and of their cut to the total has tended to increase in the last ten years.

In 1870, when the United States began its policy of alienation of its timberlands, the Government owned approximately three-fourths of the country's timber. Of the 2,215 billion feet of standing timber now in the United States the United States Forest Service estimates that about 30 per cent., or 659 billion feet, is publicly

owned, while 70 per cent., or 1,556 billion board feet, is owned privately. Of the 659 billion feet publicly owned the Federal Government has 600 billion of which about 498 billion feet or 22 per cent. of the country's timberlands is included in the national forests. State and municipal lands contain 59 billion board feet, or 3 per cent. About four-fifths of the timber in the national forests is contained in the five states of the Pacific Northwest, while only a very insignificant part of it lies east of the Rocky Mountains.

The opinion has been expressed in the lumber trade that it may be desirable ultimately to double the present acreage of the public forests. This could be done by the extension of the national forests by purchase, by exchange of stumpage for other land and by placing under permanent administration the forest lands now in the unreserved public domain. State forests might also be enlarged. Some depleted and waste cut-over and burned lands should be rehabilitated. It is not advantageous always to reforest cut-over lands, since they may offer better returns for agriculture or other industry established on them. However, where through public and private coöperation and protection the replanting of cut-over timberlands promises a fair return, reforestation seems the logical course. A public survey of forest resources and a classification of cut-over lands would facilitate a determination of whether they are more suitable for agriculture or for permanent timber growth.

Tax accumulations, the cost of protection against fires, insects and disease and the fact that timber takes generations to mature, all tend to discourage reforestation by private owners who too often take a short-sighted view of

their functions. The responsibility for reforestation, however, rests upon private owners as well as upon the public at large, and the practice of forestry should be made effective both for public forests and for privately owned timber.

PETROLEUM AND PETROLEUM PRODUCTS

IN THE sixty-odd years since American wells began production petroleum has found ever increasing world-wide use until it has become an essential of modern civilization. Crude or semi-refined petroleum is used extensively as a fuel for locomotives and steamships and in a more limited way as a lubricant. Its principal use, however, is in the form of numerous refined products, among which gasoline, kerosene, gas and fuel oil, lubricants, paraffin, coke, asphalt and petrolatum serve to illustrate the variety and multiplicity of its applications to modern needs.

PETROLEUM RESOURCES OF THE WORLD

The United States has long been preëminent in the petroleum industry, but it occupies the unenviable position of exhausting its resources much more rapidly than the rest of the world. Starting with a supply estimated at 14 billion barrels it has used up some 5 billion, leaving only about 9 billion barrels, or 64 per cent. of its original resources, still available. On the other hand, the world outside the United States is thought to have 56 billion barrels, or over 90 per cent. of its original supply of approximately 60 billion barrels. As the United States regularly produces three-fifths or more of the world's annual output, each year finds this country in a relatively worse position.

While the using up of natural resources is deplorable, still the material gains resulting from their exploitation

should not be overlooked, for in a large measure the gradual exhaustion of American petroleum has been offset by the advances of American industries thus made possible.

Table A, which was prepared from figures compiled by the United States Geological Survey, shows an estimate of the petroleum deposits remaining in the different regions of the world. Any such table is liable to a wide margin of error, but it is believed that the figures understate rather than exaggerate the amounts.

TABLE A—PETROLEUM RESOURCES OF THE WORLD

Country or region	Estimated deposits (in thousands of barrels of 42 gallons)
United States	9,000,000
Southeastern Russia, southwestern Siberia and the Caucasus	5,830,000
Persia and Mesopotamia	5,820,000
Northern South America, including Peru	5,730,000
Mexico	4,525,000
Southern South America, including Bolivia	3,550,000
East Indies	3,015,000
China	1,375,000
Japan and Formosa	1,235,000
Rumania, Galicia and western Europe	1,135,000
Canada	995,000
India	995,000
Northern Russia and Saghalien	925,000
Algeria and Egypt	925,000
Total known supply	45,055,000
Additional deposits probable	20,000,000
Grand total	65,055,000

The deposits of the United States are estimated as making up about one-fifth of the world's known supply and about one-seventh of the probable total stock. They are 2,245,000,000 barrels greater than the total for Russia, which has the second largest supply. In addition to these countries the petroleum resources of Persia and Mesopotamia and of northern South America, including Peru,

are estimated to be greater than those of Mexico although that country is now second only to the United States in annual production.

If an annual rate of 450,000,000 barrels, a figure nearly reached in 1920 and exceeded by 20,000,000 barrels in 1921, were to be maintained in the United States until the wells were exhausted, the known supply would run out in about 20 years. These oil fields, however, are likely to show long periods of declining productivity before they are completely exhausted. It is impossible to estimate when the United States will have used up its petroleum resources, but a period of constantly decreasing production with occasional increases as new wells are opened up and new methods of recovery are instituted may be expected to begin within the next few years.

To meet the emergency of a declining output of petroleum the United States has in reserve huge deposits of oil shale from which great quantities of petroleum products may be obtained when it becomes economical to produce them. Enormous amounts of oil shale rich in oil are found in northwestern Colorado, northeastern Utah, southwestern Wyoming and northern Nevada. Deposits of more limited extent and generally less rich are located in Pennsylvania, Indiana, Kentucky, Texas, Wisconsin, Michigan, West Virginia and elsewhere. Though the oil shale industry is of long standing in other parts of the world, notably Scotland, France and Australia, it has not yet passed the experimental stage in the United States.

PETROLEUM PRODUCTION OF THE WORLD

The petroleum output of the leading producing countries in the last five years is shown in Table B. Production in

Russia, Rumania, Galicia and Germany was greatly curtailed as a result of the war and has not yet recovered. Mexico, on the other hand, showed a very marked gain during recent years, producing in 1921 about 26 per cent. of the world's total output. The figures for 1921, except for the United States and Mexico, are estimates by the American Petroleum Institute, while those for 1917–20 are as reported by the United States Geological Survey. Data for a number of the countries, especially for the more recent years, are subject to a considerable margin of error. The table should be regarded, therefore, as showing the best approximations available rather than accurate statements of production.

TABLE B—WORLD'S PETROLEUM PRODUCTION

Country	1917	1918	1919	1920	1921
	(in thousands of barrels of 42 gallons)				
United States	335,316	355,928	377,719	443,402	469,639
Russia	69,960	40,456	25,498	25,430	28,500
Mexico	55,293	63,828	87,073	163,540	193,398
Dutch East Indies[1]	12,929	13,285	15,428	18,545	19,000
India	8,079	8,188	8,735	7,500	6,864
Persia	6,856	8,271	6,412	12,353	14,600
Galicia	5,965	5,592	6,054	5,606	3,665
Rumania	3,721	8,730	6,614	7,435	8,347
Japan and Formosa	2,882	2,449	2,175	2,140	2,600
Peru	2,533	2,536	2,616	2,817	3,568
Trinidad	1,602	2,082	1,841	2,083	2,354
Argentina	1,145	1,321	1,183	1,666	1,747
Egypt	1,009	2,080	1,501	1,042	1,181
Germany[2]	645	711	234	212	200
Canada	214	305	241	197	190
Venezuela	128	190	425	457	1,078
Other countries[3]	59	36	1,136	429	433
Total	508,336	515,988	544,885	694,854	757,364

[1]Including British Borneo, which in 1921 produced 1,000,000 barrels.

[2]Production of Alsace included with that of Germany until 1919. Alsatian production estimated at 344,000 barrels in 1919, at 389,000 barrels in 1920, and at 392,000 barrels in 1921.

[3]Including chiefly production of Italy, Algeria, Cuba, England, and, in 1919, 1920 and 1921, Alsace.

The advance in the Mexican output has been very rapid ever since production on a commercial scale was commenced in 1901. In that year 10,345 barrels were produced. By 1907 the output had grown to 1,005,000 barrels, and by 1913 to 25,696,291. Total production from 1901 to 1921 was 730,000,000 barrels, or more than has been obtained in any of the other producing countries, excepting the United States and Russia, from the beginning of their production to date. Of the countries shown in the table only Argentina, Trinidad, Egypt, Persia and Venezuela have had a more recent development of their oil resources than has Mexico.

Rapid exploitation of Mexican petroleum resources has been due to the fact that the wells are all gushers. Pumping, which is required in most other fields, is not necessary there as the oil is forced out under a great hydrostatic pressure. As the pools become exhausted salt water follows the oil to the surface, but it should be understood that the appearance of salt water in one pool has no significance as to the degree of exhaustion of separate and unrelated pools. Many of the wells in the Amatlan pool, located in the Tampico-Tuxpam district, have recently been showing an increasing tendency to flow salt water. The approaching exhaustion of this pool may probably be traced to the competitive conditions under which it was developed. In this region there are many small holdings by competing companies, so that each company has felt it necessary to secure all the oil possible lest other wells draining the same pool get the supply.

Most of the Mexican output is exported to the United States where it finds a market chiefly as fuel oil or asphalt, since only about 9 per cent. of gasoline and 4 per cent. of

kerosene are obtainable from the average grade. The bulk of this fuel oil is sold on the Atlantic coast of the United States where it is better able than Mid-Continent oil to compete with coal, since it enjoys an advantageous freight rate.

PETROLEUM PRODUCTION IN THE UNITED STATES

Although petroleum has been known and used since earliest times there was practically no development of the industry until oil wells came to be actively exploited in the United States. In 1859 Edwin L. Drake struck oil in a well drilled near Titusville in northwestern Pennsylvania. This well, which furnished 40 barrels at first and later only 15 barrels of petroleum a day, was the real beginning of the vast modern industry.

The Appalachian field thus opened up furnished all the oil produced in the United States from 1859 to 1875, supplied over nine-tenths of the total until 1887, and over one-half until 1901. A maximum production of 36,295,000 barrels was reached in 1900 but by 1921 the output was reduced to 30,574,000 barrels, having been as low as 22,860,000 barrels in 1915.

Table C, which shows the production of petroleum by states and fields in 1921, indicates the locations of the different fields as well as the relative importance of the states and fields in the quantity of oil produced in that year.

To a great extent the separation of producing areas into fields is determined by the fundamental differences in the types of oil produced rather than by geographic boundaries. The oils of the Appalachian field are mainly of paraffin base, free from asphalt and objectionable sulphur,

TABLE C—PRODUCTION OF PETROLEUM IN THE UNITED STATES IN 1921 BY FIELDS AND STATES

Field and State	Production (in thousands of barrels of 42 gallons)	
Mid-Continent—		
Oklahoma	113,978	
Central and northern Texas	70,892	
Kansas	36,232	
Northern Louisiana	24,793	
Arkansas	10,190	
Total		256,085
California		114,709
Appalachian—		
Kentucky	8,951	
West Virginia	8,003	
Pennsylvania	7,434	
Central and eastern Ohio	5,194	
New York	980	
Tennessee	12	
Total		30,574
Gulf—		
Coastal Texas	32,430	
Coastal Louisiana	1,730	
Total		34,160
Rocky Mountain—		
Wyoming	19,222	
Montana	1,435	
Colorado	108	
Total		20,765
Illinois		10,044
Lima-Indiana—		
Northwestern Ohio	2,139	
Indiana	1,163	
Total		3,302
Grand total		469,639

and yielding by ordinary refining methods high percentages of gasoline, kerosene and lubricants.

In 1876 the California field began production on a commercial scale with an output of 12,000 barrels. Though still showing increased production from year to year, this field reached its greatest relative importance in 1913, when

with 97,789,000 barrels it supplied nearly two-fifths of the total for the country. The California oils as a rule have much asphalt and little or no paraffin. They have varying proportions of sulphur and furnish chiefly fuel oils, lamp oils, lubricants and asphalt. Low percentages of gasoline are derived from certain of the lighter oils, especially those in the southern part of the state.

The Lima-Indiana field was the next to be developed. Starting with an output of 1,138,000 barrels in 1886 it reached its greatest production, 25,256,000 barrels, or slightly over two-fifths of the total for the United States, in 1896. These oils contain some asphalt although they are principally of paraffin base. They are contaminated with sulphur compounds which require special treatment for elimination.

Commercial production in the Rocky Mountain field began with 76,000 barrels in 1887. Its relative as well as absolute importance is still increasing although its production was less than 5 per cent. of the total in 1921. The product is mainly of paraffin base suitable for refining by ordinary methods, but heavy asphaltic oils of fuel-oil grade are also obtained in certain of the Wyoming fields.

One thousand barrels of oil were produced in the Illinois field in 1889, but less was obtained in the subsequent years until 1905 when 181,000 barrels were produced. The output reached its highest point in 1908 with 33,686,000 barrels. These oils contain varying proportions of both asphalt and paraffin, and differ as to specific gravity and distillation products. Sulphur is generally present but seldom in such form as to make necessary special treatment for its removal.

The Mid-Continent field started production with 500

barrels in 1889. Nearly every year since then has shown a marked increase and apparently the maximum has not yet been reached. It has been the chief producing field since 1915, taking rank over California in that year largely by reason of the development of the Cushing pool in Oklahoma. Petroleum from this field has widely varying characteristics. Sulphur is present in the lower grade oils, in certain of which, Healdton for example, it exists in a form necessitating special treatment for its elimination.

Development of the Gulf field likewise started in 1889, when 48 barrels were produced. The Gulf production was negligible until 1901 when 3,593,000 barrels were obtained. The output of 36,526,000 barrels in 1905 has not since been equaled. Gulf oils have high percentages of asphalt and low percentages of the lighter distillation products. Considerable sulphur is present, but much of it is in a form easily removed before refining or using the oil for fuel.

The annual production of each of the fields since 1918 is shown in Table D. The fields are named in the descending order of the quality of their product.

It is significant of the peculiar conditions prevailing in the production of petroleum that despite general busi-

TABLE D—PETROLEUM PRODUCTION IN THE UNITED STATES BY FIELDS

Field	1918	1919	1920	1921
	(in thousands of barrels of 42 gallons)			
Appalachian	25,401	29,232	30,511	30,574
Illinois	13,366	12,436	10,772	10,044
Lima-Indiana	3,221	3,444	3,059	3,302
Mid-Continent	179,383	196,891	249,074	256,085
Rocky Mountain	12,809	13,584	17,517	20,765
Gulf	24,208	20,568	26,801	34,160
California	97,532	101,564	105,668	114,709
Total	[1]355,928	377,719	443,402	469,639

[1]Includes 8,000 barrels produced in Alaska and Michigan.

ness depression accompanied by a fall in petroleum prices the output in 1921 showed an increase of 6 per cent. over 1920. The gain was shared by all but the Illinois field, in which production has regularly been falling off in recent years. When oil has been struck in a well production is maintained with little regard for the prices obtained for the product. Especially is this true where rival interests own wells draining a common pool. Not only must a producer continue to draw oil from his wells in order to get a maximum supply ahead of competitors, but this is necessary also lest the underground flow be diverted from his wells, should he shut down, with resultant loss in daily output when he resumes operations. Moreover, similar considerations compel producers on adjacent oil lands to vie with each other in drilling offsets.

Depression in the petroleum industry does, however, limit to some extent the drilling of wells in known fields, and to an even greater degree the exploration of new territory. Since production is sustained only by drilling an increasing number of wells in any given field, and since new territory must be opened up to compensate for exhaustion of old fields, a decline in drilling is after a time followed by a falling off in production. Conversely, a period of prosperity brings increased production after a delay of months.

Thus, while the increasing production in the first part of 1921 was probably a result of the prosperity in 1919 and the first part of 1920, there may be a period of declining output ahead which will reflect the depression of the first part of 1921. In this connection it should be recognized, however, that the drilling of a few very productive wells is equivalent to the bringing in of many wells

TABLE E—SUPPLY AND DISTRIBUTION OF PETROLEUM IN THE CONTINENTAL UNITED STATES

Item	1917	1918	1919	1920	1921
	(in thousands of barrels of 42 gallons)				
Production	335,316	355,928	377,719	443,402	469,639
Net imports of crude oil[1]	23,858	31,852	46,474	96,881	115,680
Total	359,174	387,780	424,193	540,283	585,319
Supplied to refineries	306,400	330,136	358,914	442,032	448,664
Added to pipe-line stocks	[2]16,355	[2]24,315	6,140	5,823	54,454
Added to other stocks, lost, or consumed in crude state	69,129	81,959	59,139	92,428	82,201

[1]Total imports minus exports to Alaska, Hawaii, the Philippine Islands, Porto Rico and foreign countries.
[2]Withdrawn.

of only moderate capacity. The number of new oil wells completed each month fell off from about 1,830 in January, 1921, to about 752 in October, the latter figure being the smallest in five years. December returns, however, showed an increase to 1,110 wells.

PETROLEUM TRADE OF THE UNITED STATES

That the importation of the low-grade Mexican oils, as well as the takings of refineries, was sustained during the depression is shown by Table E, which likewise shows that the additions to pipe-line stocks in 1921 were enormous.

Practically all the crude oil brought into the United States comes from Mexico. In view of the ever-increasing importance of the quantity of this oil in the total supply the only reason that the imports did not exert a more pronounced effect upon the domestic markets is that its quality is inferior. Exports of petroleum in crude condition are comparatively insignificant, going for the most part to Canada. Shipments of crude petroleum to Alaska,

Hawaii, the Philippine Islands and Porto Rico, though small, have been excluded from Table E in order to confine the consideration strictly to the continental United States.

Notwithstanding large imports from Mexico it was only in 1920 and 1921 that the United States retained more petroleum than it produced, when the exportation of the refined products is taken into account. In other words, except for the last two years when imports of crude oil were especially heavy, the net position of the United States with regard to petroleum and petroleum products has been that of an exporter.

By far the larger part of the crude petroleum stored above ground in the United States is held in large storage farms by the pipe-line and marketing companies. Oil thus held is described as pipe-line stocks. These stocks have a stabilizing influence upon the petroleum supply. When the demand exceeds production, as in 1917 and 1918, the shortage is met by a withdrawal of stocks from storage. In periods of overproduction, on the other hand, additions are made to stocks. Crude oil run to storage in 1919 and 1920 amounted to little over 1 per cent. of the current supply, but in 1921 the additions to stocks consisted of 54,454,000 barrels or 9 per cent. of the supply. The total gross pipe-line stocks at the end of December, 1921, amounted to 182,482,000 barrels. This quantity included 12,132,000 barrels of bottom settlings and water in the territory east of California that should not be counted as petroleum, but which have been included because the figures for the California holdings, 33,289,000 barrels, include an indeterminate amount of bottom settlings and water, some residuum and unfinished refinery products

that have been turned back to pipe lines, and also producers' stocks.

Other stocks are those of Mexican oil held in the United States by importers. These aggregated 13,540,000 barrels on December 31, 1921, as compared with 7,442,000 on December 31, 1920. Statistics for these stocks are not available for previous years. The Mexican stocks include both crude oil and oil that has been "topped," that is, oil that has been subjected to a preliminary refinery process by which the lighter products, for the most part gasoline, have been abstracted. On December 31, 1921, there were 11,125,000 barrels of Mexican crude and 2,415,000 barrels of topped oil in the hands of importers.

The refineries regularly have a considerable store of crude petroleum but the supply varies somewhat from time to time. On December 31, 1916, the refineries held 20,370,000 barrels, but at the close of 1917 a low record of 11,638,000 barrels was established. At the end of 1920 the refinery stocks of crude oil consisted of 21,261,000 barrels. By the end of 1921 this stock had grown to 26,562,000 barrels.

Most of the crude oil produced in the United States is bought by large marketing companies or purchasing departments of the big refineries at prices announced or "posted" by the purchasers. Some of the crude petroleum is bought direct by small refiners who often pay a premium on the posted price because of the limited quantities they are prepared to take. At times of overproduction in a given field, however, the small refiners may occasionally be able to buy at less than the posted price.

The posted prices of two of the leading grades of petro-

leum are shown for each month from 1913 to 1921 in Table F.

TABLE F—WHOLESALE PRICES OF CRUDE PETROLEUM AT WELLS FOR AVAILABLE DATE NEAREST THE FIFTEENTH OF EACH MONTH, 1913–21, IN DOLLARS PER BARREL OF 42 GALLONS

Month	1913	1914	1915	1916	1917	1918	1919	1920	1921
				Pennsylvania					
January	2.05	2.50	1.50	2.25	3.05	3.75	4.00	5.00	5.75
February	2.50	2.50	1.50	2.35	3.05	4.00	4.00	5.50	3.75
March	2.50	2.50	1.45	2.50	3.05	4.00	4.00	6.10	3.00
April	2.50	2.50	1.35	2.60	3.05	4.00	4.00	6.10	3.00
May	2.50	1.90	1.35	2.60	3.10	4.00	4.00	6.10	3.50
June	2.50	1.80	1.35	2.60	3.10	4.00	4.00	6.10	2.75
July	2.50	1.70	1.35	2.60	3.10	4.00	4.00	6.10	2.25
August	2.50	1.55	1.45	2.30	3.25	4.00	4.00	6.10	2.25
September	2.50	1.45	1.65	2.30	3.50	4.00	4.25	6.10	2.25
October	2.50	1.45	1.75	2.50	3.50	4.00	4.25	6.10	3.25
November	2.50	1.45	1.90	2.60	3.50	4.00	4.50	6.10	4.00
December	2.50	1.45	2.10	2.75	3.75	4.00	4.50	6.10	4.00
				Kansas-Oklahoma					
January	.83	1.03	.55	1.20	1.70	2.00	2.25	3.00	3.50
February	.88	1.05	.40	1.30	1.70	2.00	2.25	3.00	1.75
March	.88	1.05	.40	1.55	1.70	2.00	2.25	3.50	1.75
April	.88	.85	.40	1.55	1.70	2.25	2.25	3.50	1.75
May	.88	.75	.40	1.55	1.70	2.25	2.25	3.50	1.50
June	.88	.75	.40	1.55	1.70	2.25	2.25	3.50	1.25
July	.93	.75	.40	1.55	1.70	2.25	2.25	3.50	1.00
August	.98	.75	.60	.95	1.90	2.25	2.25	3.50	1.00
September	1.03	.65	.80	.90	2.00	2.25	2.25	3.50	1.00
October	1.03	.55	.80	.90	2.00	2.25	2.25	3.50	1.50
November	1.03	.55	1.00	.90	2.00	2.25	2.25	3.50	2.00
December	1.03	.55	1.20	1.10	2.00	2.25	2.50	3.50	2.00

The depression of prices in the second half of 1914 and through 1915, shown in the table, was a reflection of the great overproduction brought about by the development of the Cushing pool. With the abrupt decline in the output of the Cushing pool toward the end of 1915 and the increased demand which followed, the price rose until in 1920 it reached $6.10 a barrel for Pennsylvania crude and

$3.50 for Kansas-Oklahoma crude. The posted prices slumped in 1921 but in the latter part of October and the first part of November were advanced to $4.00 for Pennsylvania and $2.00 for Kansas-Oklahoma crude in spite of ever-accumulating stocks.

Oil is carried from the producers' field tanks to the refineries or to storage tanks by pipe lines, a relatively small amount being transported in tank cars. As the refineries are located in places convenient to the markets for their products the pipe lines are often hundreds of miles in length. In fact, the pipe-line system, including trunk lines and branches, forms a vast invisible network extending thousands of miles. The steel pipes are laid near the surface of the ground and the main lines are generally eight inches in diameter. A pumping station which maintains the flow of the oil is located on an average of every 40 miles, although the distances vary greatly, depending on the quantity and grade of the oil, topography of the country, etc.

Beginning with four miles of iron pipe laid down in western Pennsylvania at the close of the Civil War, these lines have gradually been extended to reach pool after pool and field after field as they were opened up. No lines extend eastward from the California or Rocky Mountain fields but the Mid-Continent, Illinois, Lima-Indiana and Appalachian fields all send their oil to the Atlantic seaboard by this vast transportation system. Lines also run from the Mid-Continent and Gulf fields to the Gulf ports whence shipments are made by tank steamers. The pipe lines are common carriers although the bulk of their business consists in carrying oil for the particular refining companies that own or control them.

The importance of refining to the petroleum industry is brought out in Table E, which shows that from 1917 to 1920 somewhat over four-fifths of the crude oil supply in the United States was taken by the refineries. That the proportion was less in 1921 was due to the failure of the demand for petroleum products to keep pace with the supply of crude oil.

REFINED PETROLEUM PRODUCTS

The products obtained in the course of refining depend upon the quality of crude oil and to some extent upon the completeness of the equipment of the refinery. From the better grades of oil four major "fractions" are distilled; namely, gasoline, which includes all the lighter products, kerosene, gas and fuel oil, and lubricating oils. These fractions or distillates are driven off successively by heating the crude oil to different degrees, the lighter products passing off at the lower temperatures. Poorer grades of oil may be treated only to remove gasoline, which interferes with the use of the crude as fuel as well as being too valuable to waste in that way. Other grades are separated into three products: gasoline, kerosene and fuel oil.

After the simple distillation the fractions are often subjected to complicated methods of purification and adaption to particular needs. The gasoline fraction may be further distilled into light, intermediate and heavy products. These are purified by treatment with sulphuric acid and other chemicals and finally may be distilled or filtered through fullers' earth. The more volatile products include petroleum ether and gasoline used in aviation; intermediate naphtha is ordinary commercial gasoline

chiefly used for automobiles; and heavy naphtha comprises benzine, cleaners' naphtha, and varnish makers' and painters' naphtha.

Kerosene distillate is ordinarily distilled a second time principally to remove all traces of gasoline. It is further treated chemically to purify it for its use as a lamp oil.

Gas and fuel oil is generally marketed without further treatment, the gas oil being used in conjunction with coal or alone for the manufacture of city gas. Fuel oil is widely used as a substitute for coal in steam raising, especially on locomotives, in industrial plants and on steamships. By special "cracking" processes, by which the gas and fuel oil is heated under pressure, considerable quantities of gasoline are often obtained from this fraction also.

The fourth fraction contains lubricating oils, greases and paraffin wax. The paraffin is separated from the rest of this distillate by chilling it so that the wax solidifies, and can be removed by filtering. Petrolatum, also known as "vaseline," is obtained from this fraction.

Petroleum coke and asphalt are obtained chiefly from the heavier oils coming from Mexico and California. They form the residue after gasoline, kerosene and fuel oil are removed.

In addition to these leading products there are many special products of petroleum manufactured by particular methods to adapt them to special needs.

Table G shows the percentages of the principal refined products obtained from the crude petroleum run to refinery stills in the United States in the years from 1918 to 1921.

TABLE G—PERCENTAGE OF REFINED PRODUCTS OBTAINED FROM CRUDE PETROLEUM RUN TO STILLS IN THE UNITED STATES

Product	1918	1919	1920	1921
Gasoline	26	26	27	28
Kerosene	13	15	13	10
Gas and fuel oil	54	50	48	52
Lubricating oil	6	6	6	5
Other products, losses, etc.	1	3	6	5
Total	100	100	100	100

To some extent changes in the proportion of the different products obtained probably reflect changes in the average quality of the crude oil refined, but they are governed chiefly by changes in the demand for the different products and by improvements in refining methods. Increased cracking of fuel oil and use of natural gas gasoline and the classification of more of the volatile part of the kerosene distillate as gasoline account for the gain in the proportional yield of gasoline in 1920 and 1921 which was in response to the increased demand for use in gasoline motors.

The production of petroleum products together with the stocks at the close of the year has been reported for each year since 1916 by the United States Bureau of Mines. These figures when taken in conjunction with those for exports indicate the domestic consumption of each product. Table H shows these statistics from 1916 to 1921. The quantity of crude oil run to stills is also shown.

Eighty-eight per cent. of the gasoline produced at the refineries in 1921 was consumed in the United States, 10 per cent. was exported and 2 per cent. was added to stocks. This compared with 87 per cent. consumed in 1920, 13 per cent. exported and less than 1 per cent. added to stocks.

Although exports were relatively more important in the case of kerosene than in respect to any of the other prod-

TABLE H—REFINERY STATISTICS OF PETROLEUM PRODUCTS IN THE CONTINENTAL UNITED STATES

Item	1916	1917	1918	1919	1920	1921
			(in millions of gallons)			
Crude oil run to stills........	10,374	13,236	13,693	15,184	18,224	18,621
Gasoline						
Production[1]	2,059	2,850	3,570	3,958	4,882	5,154
Consumption[1]	[2]	2,346	3,129	3,435	4,251	4,516
Net exports.............	364	419	556	373	616	514
Stocks at end of year[1] ...	327	412	297	447	462	586
Kerosene						
Production.............	1,455	1,727	1,825	2,342	2,320	1,945
Consumption[3]	[2]	1,042	1,447	1,394	1,389	1,240
Exports[3]...............	859	664	496	989	877	757
Stocks at end of year....	477	498	380	339	393	341
Gas and fuel oil						
Production.............	4,664	6,513	7,321	7,627	8,861	9,664
Consumption[3]	[2]	5,280	5,718	6,290	6,705	7,080
Exports[3 4]...............	1,195	1,376	1,522	1,282	2,033	2,090
Stocks at end of year....	721	578	659	714	837	1,331
Lubricating oil						
Production..............	625	754	841	847	1,047	878
Consumption[3]...........	[2]	[2]	580	571	619	531
Exports[3]................	262	282	259	277	405	291
Stocks at end of year....	[2]	137	139	138	161	217

[1]Not including gasoline made from natural gas except that bought by refineries.

[2]Not available.

[3]Figures for these items take no account of the relatively small amounts of imports retained for consumption, figures for which were not reported separately.

[4]Includes fuel or bunker oil laden on vessels engaged in the foreign trade and in the case of shipments to Alaska, Hawaii and Porto Rico, shipments of residuum from refining.

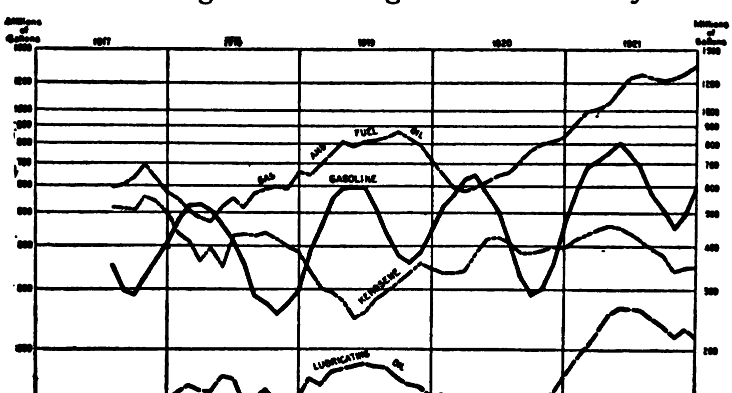
ucts, about three-fifths of the production were consumed at home both in 1920 and 1921. In both years nearly two-fifths were exported. In 1920 stocks increased 16 per cent., but in 1921 there was a slight decline. Production showed decreases in each of the years.

Industrial and shipping activity failed to keep pace with the production of gas and fuel oil and lubricants in 1920 and 1921. Thus, while there was an absolute gain in the use of both products in 1920 over 1919, the consumption of gas and fuel oil fell from 82 to 76 per cent. of pro-

duction, and the use of lubricating oil fell from 67 to 59 per cent. In 1921 consumption of gas and fuel oil still showed a gain, but only 73 per cent. of the increased production was used. The production of lubricants declined at about the same rate as the use. Exports of gas and fuel oil were well maintained in proportion to production, but exports of lubricants decreased from 39 per cent. of production in 1920 to 33 per cent. in 1921.

The accompanying chart shows the movement of the stocks of petroleum products by months from July, 1917, to December, 1921. As the curves are drawn on a semi-logarithmic scale their trends can be compared directly without regard to their relative positions on the chart. The seasonal movement in gasoline and the piling up of stocks of gas and fuel oil and lubricating oil in 1921 are strikingly shown.

Production figures extending back to 1880 may be ob-



Stocks of Petroleum Products Held at Refineries in the United States at the Close of Each Month from July, 1917, to December, 1921

tained from the records of the United States Bureau of the Census. Varying terms were used to designate the products from time to time, but in Table I the figures are shown divided as nearly as possible into the classification adopted by the United States Bureau of Mines. "Gasoline" includes naphtha and all the lighter products of distillation, the term "kerosene" is used in place of "illuminating oils", while "lubricants" includes paraffin oil, red or neutral oils, cylinder oils, other lubricating oils and greases. The amount of crude petroleum consumed by refineries in each of the census years is also shown. Comparison of Table I with Table H shows a disagreement between the two government bureaus as to the operation of refineries in 1919. They are, however, essentially in agreement as to the proportions of the different products obtained from the crude oil.

TABLE I—PRODUCTION OF PETROLEUM PRODUCTS IN THE UNITED STATES FROM 1880 TO 1919 AS REPORTED BY THE UNITED STATES BUREAU OF THE CENSUS

Year	Crude petroleum run to stills	Gasoline[1]	Kerosene	Gas and fuel oil	Lubricants
		(in millions of gallons)			
1880......	732	75	[2]551		19
1889......	1,288	165	[3]848		99
1899......	2,184	281	1,259	305	199
1904......	2,813	291	1,357	360	325
1909......	5,073	540	1,675	1,702	544
1914......	8,033	1,460	1,935	3,734	532
1919......	15,341	4,206	2,305	7,768	850

[1]Not including gasoline made from natural gas except that bought by refineries.
[2]Reported as "illuminating oils" but probably includes some gas and fuel oil.
[3]Reported as "burning oils."

KEROSENE

The first half century of the growth of the petroleum industry was characterized by a demand chiefly for illumi-

nating oil or kerosene. This product quickly displaced an illuminating oil originally obtained by the distillation of coal, which had been known as "coal oil." It likewise took the place of whale oil and other fats which had had wide use as illuminants. Even to-day it is the chief source of artificial light in districts not served with gas or electricity. As new uses for the other constituents of crude oil developed, however, illuminating oil has been relatively of decreasing importance. Much of the oil which would now be classed as fuel oil was evidently used for illuminating in the years preceding 1909. Since there was little demand for gasoline in these years as much as possible was left with the kerosene, while considerable quantities were used for lighting by means of special burners.

In recent years much kerosene has been made to serve as a motor fuel. With the growing demand for gasoline increasing fractions of potential kerosene have been drawn into the gasoline supply. Kerosene engines on tractors and motor trucks also add to the consumption of kerosene for motive power.

An export trade of large dimensions was an early development of the industry. In 1880 exports of illuminating oil amounted to 286,131,000 gallons. In this and the following years for which production statistics are available, until 1917, over half of the American production was exported. Since 1917 the importance of the export trade has declined somewhat. The quantity of exports has likewise been decreasing since 1919.

Shipments of kerosene are made to practically every country in the world. A short list of countries will suffice, however, to show the destination of the bulk of the exports. Table J shows the exports of kerosene from the United

States to foreign countries in the years from 1910 to 1914 and 1919, 1920 and 1921, by the principal countries of destination in each of these periods. Exports to Alaska, Hawaii and Porto Rico are not included. Although of considerable importance they were not nearly so large as the shipments to the countries shown separately in the table.

TABLE J—EXPORTS OF KEROSENE FROM THE UNITED STATES TO FOREIGN COUNTRIES

Country	[1]1910–14 (5-yr. aver.)	[2]1919	[2]1920	[2]1921
		(in thousands of gallons)		
United Kingdom	178,288	166,630	173,595	123,526
Netherlands	129,695	45,530	58,224	61,162
Germany	106,808	15,193	24,930	14,759
China	81,235	164,366	116,407	108,048
Japan	80,221	31,700	41,236	18,638
Belgium	50,960	17,594	22,723	21,225
France	48,267	82,400	83,365	57,181
British India	42,263	56,608	44,820	38,474
Other countries	337,776	399,134	305,365	305,946
Total	1,055,513	979,155	870,665	748,959

[1]Fiscal years ending June 30.
[2]Calendar year.

GASOLINE

In the early years of the refinery industry gasoline formed from 10 to 13 per cent. of the petroleum refined. Between 1909 and 1914, however, the proportion increased from 11 to 18 per cent. in response to the growing demands for its use in internal-combustion engines. At this time gasoline replaced kerosene as the most valuable product of crude petroleum and since then the principal concern of the refineries has been to obtain as large a fraction of gasoline as possible. In 1916 and 1917 gasoline was 20 and 22 per cent. respectively of the crude run to stills,

while in 1918 and 1919, due to additional production of cracked gasoline, it formed 26 per cent. of the crude. In 1920 it was 27 per cent. and in 1921, 28 per cent. of the crude oil distilled.

Not all the gasoline produced in refineries is obtained by the distillation of crude petroleum, however. Casinghead gasoline, otherwise known as natural gas gasoline or natural gasoline, made from natural gas, is bought by refineries to add to the volatility of the gasoline refined from oil. In 1918, 1919 and 1920 the gasoline thus purchased constituted 3 per cent. of the gasoline output of the refineries. Allowing for the casinghead gasoline in the refinery output, gasoline from distillation alone made up 25 per cent. of the crude oil run in 1918 and 1919 and 26 per cent. in 1920. Later figures are not yet available.

Gasoline is obtained from natural gas either by condensation or by absorption. The absorption process involves the dissolving of the gas in an oil heavier than gasoline and then recovering by distillation the gasoline that has been absorbed. The casinghead gasoline industry has had a remarkable development since its establishment on a commercial scale about 1909. The first report of the quantity produced was for the year 1911 when 7,426,000 gallons were obtained. By 1916, five years later, the production was 103,493,000 gallons. In 1920 it was 384,744,000 and in 1921 473,659,000 gallons. The total net output of gasoline from all sources in the United States in 1914 was 1,500,204,000 gallons; in 1918 it was 3,749,892,000 gallons; in 1919 it was 4,185,207,000 gallons; and in 1920 it was 5,134,868,000 gallons. Figures for other years are not available.

The principal countries to which the United States ex-

ports gasoline are shown in Table K together with the amount shipped to each from 1910 to 1914 and in 1919, 1920 and 1921. The increase in the exports in recent years has been very marked, especially in the case of the United Kingdom, France, Italy, Australia and New Zealand.

TABLE K—EXPORTS OF GASOLINE FROM THE UNITED STATES TO FOREIGN COUNTRIES

Country	[1]1910–14 (5-yr. aver.)	[2]1919	[2]1920	[2]1921
	(in thousands of gallons)			
Canada	33,316	31,245	54,637	43,886
United Kingdom	24,866	112,203	146,954	149,059
France	17,223	74,810	180,554	95,362
Argentina	12,025	16,008	18,464	25,789
Germany	11,057	4,230	17,060	13,244
Netherlands	9,385	4,683	4,720	14,280
Italy	6,811	24,300	33,437	15,011
Belgium	6,105	4,616	12,072	16,509
Australia	5,577	11,987	13,664	20,651
Brazil	4,567	9,038	13,070	13,809
New Zealand	3,702	8,513	19,447	19,411
Sweden	1,296	4,830	16,376	8,923
Spain	26	3,581	11,664	16,056
Other countries	11,376	62,089	99,191	81,100
Total	147,332	372,133	641,310	533,090

[1]Fiscal years ending June 30.
[2]Calendar year.

GAS AND FUEL OIL

Although petroleum and its products were doubtless used for fuel from the very beginning of the industry, fuel oil was first reported as a distinct refinery product in the census for 1899 when it formed 14 per cent. of the crude run to stills. Since 1914, however, gas and fuel oil has constituted about one-half of the crude refined. Gas oil, which is classified with fuel oil, is a high grade of fuel oil which is used principally by public utilities for the manufacture of gas for illuminating and heating purposes.

Fuel oil competes with coal. It is used extensively in the southwestern and western portions of the United States where coal is lacking, and its industrial use has even penetrated into the northeastern section. Although special devices are necessary to burn fuel oil the labor-saving in stoking and in avoiding the removal of ashes, added to the cleanliness of its use and the reduction in space required for storage, frequently are considered sufficient to offset the cost of installation and a somewhat higher unit cost than for coal.

Because of the saving in bunker space and the ease of handling it fuel oil has come into wide use on shipboard. Time spent in port is greatly reduced with oil-burning ships, thus enabling them to make more voyages per year. Approximately three-fourths of the United States Shipping Board ships in operation in 1921 were oil burners. Fuel oil stations have been established at strategic ports on the established trade routes of the world and it will soon be possible, if it is not already so, for ships to circle the globe wholly by means of fuel obtained at these stations. It is estimated that the normal minimum requirements of the Shipping Board ships alone amount to 30,000,000 barrels.

The fuel oil laden at ports of the United States on vessels engaged in foreign trade was reported first for the fiscal year 1915, when 2,898,000 barrels were so used. This increased to 5,908,000 barrels in the calender year 1917 and 6,603,000 in 1918. In 1919 there was a very marked increase to 14,031,000 barrels, and in 1920 to 26,335,000 barrels. During 1921, 27,076,000 barrels were furnished to vessels in foreign trade. These gains were all the more striking since the use of coal showed little change between 1916 and 1921.

Railroads used 37,763,000 barrels of fuel oil in 1919, the latest date for which figures are available, and in the fiscal year ending June 30, 1921, the United States Navy consumed 6,689,000 barrels. Moreover, in 1918 239,000,000 gallons or 5,690,000 barrels of crude petroleum were used on producing properties, chiefly in the California and Gulf fields, as fuel for drilling and pumping.

During the coal strike in Great Britain, manufacturers, hotels and railroads there turned to the use of fuel oil even though handicapped by lack of equipment for storing and burning the oil, the long haul from producing centers (chiefly the United States, Mexico and Trinidad) and the scarcity of railway tank cars for transportation from the ports to interior points. Since the settlement of the strike many of these firms have returned to the use of coal, but there are still some, especially food manufacturers and hotels where cleanliness is especially valuable, which find it economical to continue the use of oil.

The exports of gas and fuel oil from the United States go mainly to industrial countries which do not have sufficient local fuel for their needs or to countries like Chile, Panama and the Philippine Islands which serve as important fueling stations for ships. The shipments of gas and fuel oil to the leading countries to which the United States exported before the war and in 1919, 1920 and 1921 are shown in Table L. The two-year period 1913-14 is taken as representative of pre-war conditions since exports of gas and fuel oil were not separately reported for earlier years.

LUBRICANTS

Lubricants constitute the smallest of the four principal fractions distilled from petroleum, making up only 5

TABLE L—EXPORTS OF GAS AND FUEL OIL FROM THE UNITED STATES TO FOREIGN COUNTRIES

Country	[1]1913–14 (2-yr. aver.)	[2]1919	[2]1920	[2]1921
		(in thousands of gallons)		
United Kingdom	162,192	197,279	217,929	304,729
Canada	79,928	133,041	187,420	105,700
Chile	67,905	41,677	55,272	24,188
Panama	34,313	12,171	20,558	19,615
Netherlands	10,072	25,418	50,673	36,887
Italy	6,445	31,374	55,461	29,729
France	2,977	8,918	40,361	52,758
Egypt	869	3,494	17,626	2,330
Mexico	724	16,825	20,559	45,826
French Africa	571	....	8,330	35,661
Philippine Islands	10	7,622	23,163	17,797
Other countries	31,831	107,031	130,242	169,841
Total	397,837	584,850	827,594	845,061
Bunker, vessels in foreign trade	[3]	589,317	1,106,065	1,137,198
Grand total	[3]	1,174,167	1,933,659	1,982,259

[1]Fiscal years ending June 30.
[2]Calendar year.
[3]Bunker oil not reported. In fiscal year 1915 shipments were 121,733,000 gallons.

per cent. of the total crude oil run to stills. The percentage, however, varies widely in different sections of the country in accordance with the types of crude distilled. Lubricating oils and greases were 18 per cent. of the crude run in the Pennsylvania district in 1921, but only 1 per cent. of that run in Louisiana and Arkansas. The East Coast district, including New York, Philadelphia and Baltimore, which treats Mexican crude as well as oils from various fields of the United States, obtained 6 per cent. of lubricants from the oil refined in 1921. As this was the second largest proportion obtained, the preëminence of Pennsylvania crude as a source for lubricants is apparent.

Despite the relatively small quantities of lubricants produced the United States regularly exports about a third

of its output. Lubricants thus rank second to kerosene in the relative proportion of production exported. Table M shows the amount of lubricating oil exported to the chief foreign customers in the years from 1910 to 1914 and in 1919, 1920 and 1921. Lubricants were sent primarily to industrial countries lacking sufficient supplies of their own but shipments were made to almost every country in the world.

TABLE M—EXPORTS OF LUBRICATING OIL FROM THE UNITED STATES TO FOREIGN COUNTRIES

Country	[1]1910–14 (5-yr. aver.)	[2]1919	[2]1920	[2]1921
	(in thousands of gallons)			
United Kingdom	58,046	69,889	118,908	61,181
France	23,046	42,510	65,940	38,781
Germany	22,861	8,194	34,530	50,168
Netherlands	11,524	10,561	7,008	4,446
Belgium	11,482	19,285	27,031	20,624
Italy	8,185	13,958	22,931	20,478
British India	8,074	9,376	9,374	10,275
Argentina	4,207	6,495	10,094	7,923
Sweden	1,550	8,805	10,300	2,383
Other countries	42,376	85,722	96,005	73,058
Total	191,351	274,795	402,121	289,317

[1]Fiscal years ending June 30.
[2]Calendar year.

Although exports of all petroleum products except gas and fuel oil fell off in 1921 as compared with 1920 the decline was most marked in exports of lubricants. The largest decreases were in shipments to the United Kingdom and France, but there were declines in the exports to all parts of the world except British India and Germany. Increased exports to Germany reflected in part the importation of lubricants into Germany in bulk for reëxportation in suitable containers, as well as increased industrial activity in that country. The general falling off

of exports and the decrease in domestic consumption of lubricants were a measure of the world-wide industrial depression.

The outstanding features in the markets for each of the principal petroleum products in 1921 were the increased production of gasoline to keep pace with the gain in consumption, the curtailed output of kerosene, the increased production of gas and fuel oil, and the decrease in the exports of lubricating oil.

RUBBER

RUBBER was among the many substances discovered with the New World. Columbus and the Spanish and Portuguese missionaries who followed him reported a new material which they found the natives using for balls, ornaments, waterproof shoes and other clothing. Scientific studies of rubber were not undertaken, however, until French interest was aroused by specimens gathered by La Condamine in Ecuador in the first half of the eighteenth century, but in the latter half of the century many experiments were carried on in Great Britain and the United States as well as in France. At some time between 1770 and 1780 Joseph Priestly, the English chemist, discovering that rubber would erase pencil marks, gave it its English name from this property. In 1832 Ludersdorf found that sulphur added to a solution of crude rubber in turpentine rendered it non-adhesive. Seven years later Charles Goodyear discovered quite by accident that when heated to a high temperature such a solution changed the characteristics of the rubber from a sticky unstable material to the vulcanized rubber as it is known to-day.

Although rubber-waterproofed garments and shoes had been made in Europe prior to this time, the vulcanization of rubber made it available for many additional uses. Rubber hose was originated by Charles Macintosh and Thomas Hancock of London. A patent on rubber tires

was taken out by Robert William Thompson in 1845, which was followed forty-three years later by a patent granted to Dunlop on a pneumatic rubber tire. To-day, from erasers to balloon fabrics and from spectacle frames to street paving, the uses of rubber are countless and are ever increasing.

The United States consumes about two-thirds of the world's rubber, but except for a relatively small amount grown in the Philippines, produces none. Until 1913 Brazil was the chief source of rubber. Since then, however, the cultivated trees in the Far East have come into bearing so that now the plantations furnish nine-tenths of the supply. Great Britain, through ownership either of the plantations or of the territories where estates are located, controls about four-fifths of the plantation output.

Rubber plantations date from 1876, when a quantity of the seeds of the *Hevea braziliensis* was taken from Brazil to the botanical gardens at Kew, England, sprouted there, and later in the same year shipped to Ceylon. Most of the rubber trees which have spread throughout the East Indies owe their origin to these seeds, though rubber is also obtained from a number of other types of trees.

India rubber is obtained from the latex or white milky fluid secured from rubber trees by a variety of methods of tapping. Different methods, also, are used to coagulate the rubber. In South America the rubber is ordinarily prepared by dipping a paddle in the fluid and turning it in the smoke from the burning of oily palm nuts. Plantation latex, on the other hand, is usually placed in large vats and acetic acid or lime juice is added. The rubber, separated in a spongy mass, is washed, dried, cut up and passed between rollers from which it issues in the form of

sheets or crêpe. As a consequence of the more careful handling plantation rubber comes on the market containing only about 3 per cent. moisture, dirt and other foreign matter, while the native rubber sometimes averages as much as 25 per cent. foreign matter. Nevertheless, the native Para rubber is considered superior to the plantation product and is preferred for many uses.

Table A, which was compiled from figures published by W. H. Rickinson & Son of London, summarizes the world's rubber production from 1900 to 1921. The part played by plantation rubber in bringing about the remarkable increase in production from 53,890 gross tons in 1900 to 293,960 tons in 1921 is clearly shown by these figures.

TABLE A—WORLD PRODUCTION OF CRUDE RUBBER

Year	Plantation	Brazil	Native areas other than Brazilian	Total	Per cent plantation
	(amounts are in gross tons)				
1900.........	4	26,750	27,136	53,890	[1]
1901.........	5	30,300	24,545	54,850	[1]
1902.........	8	28,700	23,632	52,340	[1]
1903.........	21	31,100	24,829	55,950	[1]
1904.........	43	30,000	32,077	62,120	[1]
1905.........	145	35,000	27,000	62,145	[1]
1906.........	510	36,000	29,700	66,210	1
1907.........	1,000	38,000	30,000	69,000	1
1908.........	1,800	39,000	24,600	65,400	3
1909.........	3,600	42,000	24,000	69,600	5
1910.........	8,200	40,800	21,500	70,500	12
1911.........	14,419	37,730	23,000	75,149	19
1912.........	28,518	42,410	28,000	98,928	29
1913.........	47,618	39,370	21,452	108,440	44
1914.........	71,380	37,000	12,000	120,380	59
1915.........	107,867	37,220	13,615	158,702	68
1916.........	152,650	36,500	12,448	201,598	76
1917.........	213,070	39,370	13,258	265,698	80
1918.........	255,950	30,700	9,929	296,579	86
1919.........	285,225	34,285	7,350	326,860	87
1920.........	304,816	30,790	8,125	343,731	89
1921.........	271,233	19,837	2,890	293,960	92

[1]Less than 1 per cent.

PLANTATION RUBBER

Twenty years ago practically all rubber in commercial use was what is known as "wild" rubber. It was produced from native trees and vines of the tropical forests of South and Central America, East and West Africa and Asia. The development of the remarkably efficient plantations, however, has rendered cultivated rubber trees the dominant factor in the rubber supply.

The best estates are in the Federated Malay States and on the east coast of Sumatra. Undertakings in Borneo also are very productive. Java, on account of its periodic and sometimes prolonged droughts, is less well suited to rubber production. Ceylon, which is now cultivated almost to the limit, lacks the soil fertility of these other regions because of the cultivation of other crops there for years before the rubber tree was introduced. South India is still less adapted to rubber growing since it combines the handicaps of unreliable climate and partially exhausted soil. Nevertheless, in the Dutch East Indies, Ceylon and South India crops other than rubber are grown on the estates and by this means the cost of rubber production is reduced to a minimum.

Table B shows the location and acreage of the rubber plantations on January 1, 1920, together with the production and the yield per acre in 1920. It is to be noted that the production figures, being from an independent source, are 10 per cent. above the estimate shown in Table A for the same year. The table was prepared by a Royal Trade Commission that recently presented its report to the governor of the Straits Settlements. The high yield per acre accredited to Ceylon is probably to be at-

tributed chiefly to the age of the trees on plantations there.

TABLE B—LOCATION AND AREA OF RUBBER PLANTATIONS ON JANUARY 1, 1920, AND PRODUCTION IN 1920

Country	Area planted (acres)	Area in bearing (acres)	Production (gross tons)	Yield per acre in bearing (pounds)
Malaya	1,750,000	1,250,000	193,000	346
Dutch East Indies	885,000	570,000	85,000	334
Ceylon	398,000	267,000	42,000	352
South India	65,000	43,000	7,000	259
Burma	45,000	17,500		
Borneo and Sarawak	50,000	30,000	8,000	199
Other countries	130,000	60,000		
Total	3,323,000	2,237,500	335,000	335

Next to the British, the Dutch, who own nearly one-seventh of the plantation acreage, are the principal rubber growers. The French and the Belgians also have extensive holdings, and in recent years American rubber manufacturers have entered the field, so that now they own about 3 per cent. of the total acreage. Of the American estates, 157,000 acres are in Sumatra and 2,000 acres are in Java, 46,200 acres being planted and in bearing, 22,800 planted but not yet in bearing, and 90,000 being held in reserve.

A rubber tree begins to produce when about five years old and between the fifth and eighth years the annual production increases from three to four-fold. Although there probably is a limit to the productive power, experience has not yet demonstrated it. Apparently each year brings an increased yield. Conservative estimates place the ultimate annual production likely to be attained at 350 pounds an acre.

Due to the lapse of five years between the planting of

the trees and their coming into bearing it is possible from estimates of plantings through 1921 to approximate the acreage of the rubber plantations in bearing up to the end of 1926. As no estimates are available as to the abandonment of acreage due to conditions brought about by the overproduction of rubber, no allowance can be made for decreases on account of this factor. Table C has been compiled from figures published by W. H. Rickinson & Son, and shows the acreage of plantation rubber trees in bearing at the close of each year from 1910 to 1926, plantation rubber production and yield per acre from 1910 to 1921 and estimated production at an assumed yield of 300 pounds per acre from 1922 to 1926. The table shows the extent to which production was curtailed in 1921 to meet the economic conditions which developed in that year. Estimates of future output are a measure of the rubber which might readily be obtained should the need arise, rather than forecasts of the amount which will actually be produced. In fact, if demand becomes insistent the yield may be considerably greater than the estimates shown.

PRINCIPAL RUBBER-CONSUMING COUNTRIES

Although crude rubber, whether produced in South or Central America, Africa or the East Indies, is distinctly a product of the tropics, it is manufactured principally in North America and Europe. Much of the rubber is shipped directly to the United States, the chief user, but considerable quantities are sent also to the United Kingdom, the Netherlands and other European countries which act as distributing centers. During 1919 and 1920 stocks of raw rubber accumulated in the United States, in the Far

East and in England far beyond current needs. In the second half of 1919 and the first half of 1920 imports into the United States were very heavy, while shipments retained in Great Britain were relatively light. In the second half of 1920 and the first half of 1921, on the other hand, the

TABLE C—ACREAGE AND PRODUCTION OF PLANTATION RUBBER

Year	Acres in bearing at close of year	Gross tons produced during year	Pounds produced per acre in bearing
1910	116,500	8,200	158
1911	294,200	14,419	110
1912	506,550	28,518	126
1913	687,350	47,618	155
1914	861,150	71,380	186
1915	1,122,550	107,867	215
1916	1,505,350	152,650	227
1917	1,817,350	213,070	263
1918	2,021,750	255,950	284
1919	2,181,050	285,225	293
1920	2,293,750	304,816	298
1921	[1]2,458,950	271,233	[1]247
1922	[1]2,611,350	[2]349,734	[2]300
1923	[1]2,759,950	[2]369,636	[2]300
1924	[1]2,910,750	[2]389,833	[2]300
1925	[1]3,020,750	[2]404,565	[2]300
1926	[1]3,069,750	[2]411,127	[2]300

[1]No allowance made for abandonment of acreage.
[2]Estimated.

United States reduced its imports. As a consequence stocks in London and the six recognized public warehouses in Liverpool increased from 27,744 gross tons at the end of July, 1920, to 82,844 tons on August 31, 1921. Production was greatly curtailed on the plantations, and raw rubber was even used as fuel. The latter part of 1921 showed increased imports into the United States, decreases in the stocks in Great Britain, and a moderate rise in prices for crude rubber. Because of such changes in conditions the quantities of raw rubber retained by various countries

give but a poor indication of the rubber consumption of those countries in any particular year. Nevertheless, the relative position of a country as a consumer of crude rubber can be approximated by its net imports over a period of years; that is, by its imports of rubber minus its exports. Table D, which was compiled mostly from official sources, shows the net imports of crude rubber into the chief consuming countries from 1913 to 1920. Australia, which is not included in the table, imported about 3,000 tons in 1920. Later figures are not available.

It should be recognized that the figures in Table D are not altogether comparable. Those for the United States relate to crude india rubber only, while those for the United Kingdom, as noted in the table, include reclaimed and waste rubber in the returns for 1913 and 1914, but for later years relate exclusively to crude rubber. Most of the countries on the continent of Europe, as well as Canada and Japan, combine figures for the trade in gutta-percha with those for the trade in india rubber. It is likely, moreover, that the commerce in the related substances, balata, guayule and jelutong, which is stated separately in the trade reports of the United States, is reported in combination with that of india rubber in the statistics of other countries.

Net imports of india rubber into the United States in 1921 were 69,000 tons less than in 1920 but were over four times as large as the net imports into the United Kingdom, the next largest importer. They were 61 per cent. of the total estimated production in 1921 as compared with 72 per cent. in 1920.

The sources of the rubber imported into the United States in the calendar years 1919, 1920 and 1921, as com-

TABLE D—CRUDE RUBBER RETAINED IN THE PRINCIPAL RUBBER-CONSUMING COUNTRIES, 1913 TO 1921

Country	1913	1914	1915	1916	1917 (in gross tons)	1918	1919	1920	1921
United States	49,852	61,250	96,794	116,478	177,088	142,772	236,977	248,763	179,669
United Kingdom[1]	25,275	18,570	15,072	26,760	25,947	30,044	42,671	56,844	42,116
Germany	16,264	11,000	6,000	3,000	2,000	1,000	4,000	11,903	21,583
Russia[2]	12,560	11,199	13,286	7,500	7,500	2,000	1,500	500	[3]
France	6,647	4,974	10,790	14,527	18,879	16,151	20,097	15,778	14,826
Belgium	3,588	[3]	[3]	[3]	[3]	[3]	3,984	3,840	1,705
Austria	2,752	1,868	547	569	169	[3]	[3]	1,426	883
Italy	2,505	2,739	4,956	4,768	5,594	7,140	9,894	6,123	3,780
Netherlands	2,390	1,799	2,900	[3]	[3]	[3]	2,771	5,510	1,022
Canada	1,987	2,904	4,426	4,803	5,846	8,132	8,616	11,911	8,161
Japan[2]	1,188	1,021	1,729	2,937	3,718	7,246	10,688	6,015	22,981
Sweden	1,039	960	991	1,140	457	500	1,925	1,567	814
Spain[2]	[3]	594	986	1,671	1,316	829	3,705	4,109	3,557
Norway	338	286	600	346	205	208	401	242	191
Denmark	111	125	316	344	120	6	695	500	254

[1]Figures for United Kingdom for 1913 and 1914 relate to crude rubber, including reclaimed and waste rubber; later figures relate to crude rubber exclusive of reclaimed and waste rubber.

[2]Figures relate to gross imports; figures for net imports not available.

[3]Figures not available.

pared with the five fiscal years from July 1, 1909, to June 30, 1914, are shown in Table E. Of the total, 77 per cent. came directly from the East Indies in 1921, as compared with only 8 per cent. before the war.

TABLE E—IMPORTS OF INDIA RUBBER INTO THE UNITED STATES

Country	[1]1910–14 (5-yr. aver.)	[2]1919	[2]1920	[2]1921
		(in gross tons)		
Brazil	17,987	26,270	16,510	10,390
United Kingdom	12,829	26,898	33,615	18,536
British East Indies:				
British India	11	2,186	1,579	921
Straits Settlements	1,870	119,328	132,343	97,854
Other	1,831	25,640	23,188	20,846
Total, British East Indies	*3,712*	*147,154*	*157,110*	*119,621*
Germany	3,244	....	....	....
Belgium	2,796	....	642	600
France	1,482	1,076	1,602	261
Netherlands	262	1,178	395	9,215
Dutch East Indies	59	27,348	32,310	23,666
Other countries	4,833	9,335	10,738	3,105
Grand total	47,204	239,259	252,922	185,394

[1]Fiscal years ending June 30.
[2]Calendar year.

The Rubber Association of America estimates that in all, 93 per cent. of the imports in 1921 were from plantations; 6 per cent. were of the grades known as Paras and Caucho—that is, rubber from the Amazon district of Brazil and rubber from Peru; and 1 per cent. came from Africa. Guayule rubber, derived from the guayule shrub of Mexico; Centrals from Central America; and Manicoba and Matto Grosso rubber from the southern states of Brazil made up less than 1 per cent. of the total. In 1913 plantation rubber made up 47 per cent. of the imports, Paras and Caucho 36 per cent., Guayule 5 per cent.,

and Africans, Centrals, and Manicoba and Matto Grosso combined, 1.2 per cent.

MANUFACTURES OF RUBBER

Although rubber is manufactured into a great variety of different articles, one American concern alone being reported as making nearly 30,000 different products, over two-thirds, and at times over four-fifths, of all the crude rubber consumed in the United States enters into the manufacture of tires and tubes.

In the course of rubber manufacturing, reclaimed rubber is utilized in combination with virgin crude rubber to an extent that varies according to the character of the product. Out of 503 questionnaires sent out during the war inquiring as to the quantity of crude and reclaimed rubber used in 1917 for different purposes, 448 replies were received. The results were as summarized in Table F. As the industry was operating under wartime difficulties it is probable that as much reclaimed rubber as practicable was being used. Since the prices of crude rubber later fell to less than one-third of those then prevailing the percentage of reclaimed used more recently may well be lower than in 1917. Reclaimed rubber, however, has a definite place in rubber manufacture.

More recent but not so complete information as to the crude rubber used in the industry is available for 1921 through answers to questionnaires covering most of the industry. According to this report tires and tire sundries took 81 per cent. of the crude rubber used by the firms replying, mechanical rubber goods 6 per cent., boots and shoes 7 per cent. and other products 6 per cent. The relative amount of rubber used for tires and tire sundries

showed an increase from 79 per cent. of the total as reported for the preceding year.

The same report shows that the amount of crude rubber held by importers, dealers and manufacturers in the United States on December 31, 1921, was about 125,000

TABLE F—CONSUMPTION OF RUBBER IN THE UNITED STATES IN 1917 BY ARTICLES PRODUCED

Article	Total	Crude rubber	Reclaimed rubber	Per cent. crude
	(amounts are in gross tons)			
Tires and tubes:				
Automobile pneumatic casings	91,161	76,336	14,825	84
Automobile pneumatic tubes	17,144	16,762	382	98
Solid tires	14,717	11,686	3,031	79
Motorcycle and bicycle tires and tire sundries	5,583	2,815	2,768	50
Total	128,605	107,599	21,006	84
Mechanical rubber goods (belting, hose, packing, etc.)	46,121	14,171	31,950	31
Boots and shoes	28,810	12,824	15,986	45
Insulated wire and insulating compounds	11,189	2,684	8,505	24
Waterproof clothing, cloth and sheeting	7,843	2,176	5,667	28
Druggists' and stationers' sundries and surgical rubber goods	3,908	3,732	176	95
Hard rubber goods	3,328	1,165	2,163	35
Rubber cement	1,470	1,462	8	99
Miscellaneous	3,824	1,800	2,024	47
Grand total	235,098	147,613	87,485	63

tons or nearly eight months' supply at the rate of consumption reported for the last half of the year. Four months' supply is regarded as a normal amount of crude rubber in the hands of traders and manufacturers under usual conditions.

Since November, 1920, a varying number of manufacturers have reported their production, shipments and stocks of tires and tubes to the Rubber Association of America. It is stated that the returns received for the later months are considered to cover over 80 per cent. of the industry. The reports for casings and tubes, which accounted for 57 and 16 per cent., respectively, of the rubber consumed in 1921, were as shown in Table G.

TABLE G—PRODUCTION, DOMESTIC SHIPMENTS AND STOCKS OF TIRES AND TUBES IN THE UNITED STATES

	Month	Number of manufacturers reporting	Production (000 omitted)	Domestic shipments (000 omitted)	Stocks at end of month (000 omitted)
			PNEUMATIC CASINGS		
1920	November	36	650	806	5,880
	December	43	506	1,327	5,508
1921	January	45	703	965	5,320
	February	45	820	1,074	5,193
	March	46	1,163	1,615	4,597
	April	49	1,651	1,786	4,527
	May	59	2,101	2,086	4,452
	June	63	2,313	2,644	4,154
	July	63	2,571	2,758	3,892
	August	66	3,043	2,894	3,935
	September	63	1,929	2,048	3,341
	October	64	1,928	1,675	3,545
	November	64	1,757	1,343	3,908
	December	64	1,840	1,980	3,697
			INNER TUBES		
1920	November	40	743	921	6,132
	December	43	508	1,481	5,787
1921	January	47	741	1,043	5,586
	February	46	917	1,130	5,415
	March	48	1,346	1,644	5,045
	April	51	1,762	1,984	4,917
	May	57	2,210	2,343	4,752
	June	60	2,360	3,233	3,835
	July	61	3,021	3,603	3,123
	August	64	4,430	3,804	3,649
	September	62	3,275	2,646	3,828
	October	64	2,844	2,016	4,732
	November	63	2,126	1,540	5,204
	December	64	2,070	2,523	4,731

The chemistry of rubber manufacture is very complicated, since many substances besides rubber enter into rubber products. The development so far reached is for the most part the achievement of the American rubber industry. The process of vulcanization, the basis of all rubber manufacture, calls for the use of sulphur, $2\frac{1}{2}$ to 10 per cent. if soft rubber is to be made, or about $33\frac{1}{3}$ per cent. if hard rubber is desired. In addition different colors and qualities are obtained by using varying quantities of many different compounding ingredients.

Raw rubber, especially that from native sources, must be washed to remove the impurities. It is afterward dried and then put into a mixer where the compounding ingredi-

ents are incorporated with it. The kind of further treatment depends upon whether the product is to be molded, hand-made from sheets, or dipped. The material may be shaped like dough and then vulcanized, it may be made into sheets which are later made into the desired articles, or it may be dissolved in benzine or gasoline for use in dipping. Surgeons' gloves, toy balloons and similar articles are made by dipping a form of the proper shape into such a solution.

Many of the uses of rubber depend upon its being reinforced by fabrics. Cotton fabric gives rubber belting its tensile strength and body. The framework of the automobile tire is built up of cotton fabric or cords. Waterproof clothing is made of rubberized fabric. Rubber boots and shoes are made from rubber-coated cloth. The two processes of combining cloth with rubber are known as "frictioning" and "spreading." Frictioning forces the rubber into the cloth, while spreading lays a thin coat of rubber over it.

The development of the rubber industry in the United States is far ahead of that in any other country. Consequently, the course of the American export trade in rubber goods reflects to a large extent the demand for rubber products throughout the world. The increase in value of products exported in 1920 over previous years was very marked, as was also the falling off in 1921 due to the world-wide industrial depression.

The domestic market, however, absorbs the bulk of American rubber products. The latest census of manufactures, that for 1919, showed that products to the value of $1,138,000,000 were manufactured, but exports in that year were valued at only $53,866,000 or less than

5 per cent. of the production. The total value of products was estimated at $896,000,000 in 1917 when the value of exports was $34,789,000 or less than 4 per cent. of the output.

Table H shows by classes of goods the value of the exports of rubber manufactures from the United States in the calendar years 1919, 1920 and 1921 as compared with the annual average for the five fiscal years from July 1, 1909,

TABLE H—VALUE OF EXPORTS OF MANUFACTURES OF INDIA RUBBER FROM THE UNITED STATES

Article	[1]1910–14 (5-yr. aver.)	[2]1919	[2]1920	[2]1921
	(in thousands of dollars)			
Automobile tires:				
Casings	[3]	[3]	43,899	13,422
Inner tubes	[3]	[3]	4,813	1,232
Solid tires	[3]	[3]	3,332	1,300
Total	*[4]3,048*	*28,925*	*52,044*	*15,954*
All other tires	[4]579	1,557	1,080	359
Boots and shoes:				
Boots	[3]	715	1,012	568
Shoes	[3]	4,551	9,738	2,829
Total	*1,652*	*5,266*	*10,750*	*3,397*
Soles and heels	[3]	[3]	984	512
Belting, hose and packing:				
Belting	[3]	[3]	3,532	1,446
Hose	[3]	[3]	3,341	1,945
Packing	[3]	[3]	1,525	716
Total	*2,284*	*6,100*	*8,398*	*4,107*
Druggists' rubber sundries	[3]	1,271	1,891	875
Reclaimed rubber	792	840	829	155
Scrap and old rubber	712	809	788	424
All other rubber manufactures	3,376	9,098	8,723	5,003
Grand total	12,443	53,866	85,437	30,786

[1]Fiscal years ending June 30.
[2]Calendar year.
[3]Not reported separately.
[4]Four-year average, 1911–14.

to June 30, 1914. Over two-fifths of the value of the exports in 1921 was made up by the value of the exports of automobile tire casings, while about one-tenth was composed of the value of rubber shoes exported. Changes in the price level were, of course, a factor in the increase of 1919 and 1920 valuations over those for the five-year average, and the decline shown for 1921 as compared with 1920.

The value of automobile tire exports showed a larger decline in 1921 as compared with 1920 than the value of the exports of any of the other major rubber products. Much of the decrease was due to the lowered prices for

TABLE I—VALUE OF EXPORTS OF AUTOMOBILE TIRES FROM THE UNITED STATES

Country	[1]1911–14 (4-yr. aver.)	[2]1919	[2]1920	[2]1921
	(in thousands of dollars)			
Belgium	118	533	1,279	74
Denmark	7	1,254	959	279
France	132	3,535	2,369	384
Germany	141	33	577	13
Netherlands	1	1,044	1,813	112
Norway	2	846	1,430	320
Spain	1	825	1,925	312
Sweden	25	1,374	2,619	568
United Kingdom	1,228	1,509	4,330	3,357
Canada	847	1,021	2,704	1,045
Mexico	152	806	1,439	1,365
Cuba	29	2,013	3,410	1,362
Argentina	11	1,788	3,127	838
Brazil	24	1,018	1,965	227
British India	1	557	1,096	391
Straits Settlements	2	636	1,109	112
Dutch East Indies	3	687	1,713	502
Australia	45	752	1,498	261
New Zealand	20	1,024	2,256	615
Philippine Islands	102	1,373	2,431	657
British South Africa	15	480	1,778	256
Other countries	142	5,817	10,217	2.904
Total	3,048	28,925	52,044	15,954

[1]Fiscal years ending June 30.
[2]Calendar year.

tires but it is probable also that the number of tires exported to most countries decreased. The values of the automobile tire exports from the United States in the four fiscal years from 1911 to 1914, and in the calendar years 1919, 1920 and 1921 are shown by countries of destination in Table I. The pre-war average is confined to four years because the exports for 1910 were not reported separately.

Table J shows the number of pairs of rubber shoes exported from the United States in the fiscal year ending June 30, 1913, and in the calendar years 1919, 1920 and 1921 by principal countries. Rubber shoes were first itemized separately in the official returns for the fiscal year 1913; therefore the statistics for the single year, rather than an average of a number of pre-war years, are shown.

TABLE J—EXPORTS OF RUBBER SHOES FROM THE UNITED STATES

Country	[1]1913	[2]1919	[2]1920	[2]1921
		(in pairs)		
Denmark	52,776	500,219	414,933	105,634
Finland	48	73,852	448,011	124
France	54,252	75,281	426,158	7,030
Germany	237,409	1,007	17,937	94
Norway	28,735	951,146	1,412,739	259,418
Turkey in Europe	109,790	427,887	546,488	36,219
United Kingdom	757,404	1,053,842	2,073,418	194,910
Canada	82,624	131,222	119,966	33,221
Cuba	1,386	350,159	1,229,909	292,810
Brazil	76,031	92,834	269,023	54,153
Japan	46,717	393,679	400,880	257,779
Australia	340,938	151,673	60,334	8,558
Other countries	443,357	1,591,687	2,668,715	1,418,900
Total	2,231,467	5,794,488	10,088,511	2,668,850

[1]Fiscal year ending June 30.
[2]Calendar year.

TREND OF RUBBER PRICES

The whole story of the development of the rubber industry is reflected in the price quotations for the crude

material. The prices of the leading grades of plantation and Para rubber in New York are shown by months from 1913 through 1921 in Table K. The table shows a decline in 1913 followed by fluctuating prices with a general trend neither up nor down during the war, a movement which was succeeded in turn by a decline in 1919, becoming precipitous in 1920 and the first part of 1921. This movement was followed by a moderate recovery toward the end of 1921.

TABLE K—WHOLESALE PRICES OF CRUDE RUBBER IN NEW YORK FOR AVAILABLE DATE NEAREST THE FIRST OR FIFTEENTH OF EACH MONTH, 1913 TO 1921, IN CENTS PER POUND

Month	[1]1913	[1]1914	[1]1915	[1]1916	[1]1917	[2]1918	[2]1919	[2]1920	[2]1921
				Plantation—First Latex Crêpe					
January	110[illegible]	56[illegible]	86[illegible]	99[illegible]	79	57	55	53[illegible]	21[illegible]
February	104[illegible]	61[illegible]	60[illegible]	78	75[illegible]	55[illegible]	56	48	20
March	97[illegible]	61[illegible]	62[illegible]	93[illegible]	86[illegible]	57	53	48[illegible]	18[illegible]
April	95[illegible]	63[illegible]	62	88	81	60	49[illegible]	45	18[illegible]
May	80	68	58[illegible]	78[illegible]	83[illegible]	63	47	38	18[illegible]
June	80	58	60[illegible]	67	80	63	37	38	14
July	71	56[illegible]	63	60	65[illegible]	63	40	33	16[illegible]
August	68[illegible]	54[illegible]	63	58	67	63	43	31[illegible]	15
September	67[illegible]	72[illegible]	59[illegible]	56[illegible]	66[illegible]	63	55	25	14[illegible]
October	53	61[illegible]	59[illegible]	60	65[illegible]	59	51	24	16[illegible]
November	53[illegible]	60[illegible]	61[illegible]	63[illegible]	63[illegible]	63	54[illegible]	20	18[illegible]
December	58[illegible]	75[illegible]	75	73	56	62[illegible]	52	17[illegible]	20[illegible]
				Para—Upriver Fine					
January	111[illegible]	73[illegible]	75	87[illegible]	78	58	60	49	18
February	104[illegible]	75[illegible]	60[illegible]	76	77	57	58[illegible]	45[illegible]	17[illegible]
March	96[illegible]	75[illegible]	58[illegible]	77[illegible]	80	59	56[illegible]	42	17[illegible]
April	92[illegible]	74[illegible]	58	74[illegible]	76[illegible]	61	55	42	16[illegible]
May	82[illegible]	74[illegible]	60	70[illegible]	75	68	56	39[illegible]	18
June	90[illegible]	70[illegible]	61	66	74	68	56	37[illegible]	16
July	87[illegible]	68[illegible]	62[illegible]	65[illegible]	69	68	55	34[illegible]	16[illegible]
August	85[illegible]	72[illegible]	60[illegible]	66[illegible]	68[illegible]	68	54[illegible]	32[illegible]	17[illegible]
September	88[illegible]	77[illegible]	57	69	68[illegible]	68	55[illegible]	27	19[illegible]
October	81[illegible]	64[illegible]	57[illegible]	73	66[illegible]	63	53	24[illegible]	22[illegible]
November	73[illegible]	65[illegible]	56[illegible]	81	63[illegible]	66	52	22	23
December	76[illegible]	71	68	79	55	61	47[illegible]	19[illegible]	23

[1]Prices as of first of month.

[2]Prices as of fifteenth of month.

The fall in the price of rubber, which has been more or less steadily in progress since the high price of $3.00 a pound was reached in the spring of 1910, was checked at

the outbreak of the war by the uncertainty of receiving continuous supplies of crude rubber from overseas, and by the increased demand for rubber products for war purposes. At the close of the war the increased output of the plantations together with about 55,000 tons of the 1918 production, which had been kept in the Far East by the scarcity of shipping, came on the market and broke the price. In 1920–21 the business depression which was reflected in the falling prices for other commodities also had its effect.

The peak price for rubber reached in 1910 was due to its greatly increased use for automobile tires, a use which up to that time had developed much more rapidly than the output of the plantations. The years 1909 and 1910, moreover, were the period when the valorization scheme, familiar to Brazilians in the case of coffee, was applied to Para rubber, and an attempt was made to corner the rubber market. Great excitement prevailed in the rubber trade at this time because the plantations were proving so profitable that there was a great speculative boom in rubber planting, company after company being floated in London for this purpose. The price in 1910 was the culmination of a gradual upward movement which had been in progress since early in 1908, when a price of 67½ cents a pound for upriver fine Para had been reached in a gradual decline from an average of $1.28½ in 1905.

Although the low rubber prices prevailing in 1921 were partially due to the world-wide business depression and also were influenced by the lack of buying power in Europe, particularly on the part of Germany and Russia, both large consumers before the war, the slump was primarily due to overproduction.

From the latter part of 1920 through 1921 prices for rubber at New York were below the cost of production on many plantations. To remedy this situation a voluntary scheme of curtailment of output by 25 per cent. was undertaken beginning November 1, 1920, by a considerable group of plantation operators. Growers in Malaya went even further by requesting the local authorities for legislation to restrict production by 50 per cent. As there is a large acreage in Chinese and native hands it was felt that legislation was necessary to enforce reduction of output other than the restriction naturally brought about by the low price for rubber and the expense of storing it. The agreement for restriction of output lapsed at the end of 1921.

Curtailed output may bring relief to the growers temporarily but the chief hope for permanent benefit lies in the fact that rubber is a comparatively new commodity for which new uses are constantly being developed. This extension is bound to progress as long as crude rubber remains relatively cheap. Already it is coming into use as a road paving and in the form of hard rubber wood it is being increasingly substituted for ordinary wood with satisfactory results. The time when common articles of furniture will be made from rubber may not be far distant. The next few years may also see sponge rubber widely used in upholstery, rubber in liquid form incorporated in paints, rubber used in linoleum, in paper, and in many other novel ways. At any rate, it should be borne in mind that rubber manufacture is a comparatively young industry which has wonderful possibilities.

SILK

SILK, which but a few decades ago was regarded as an article of luxury to be used only by the very wealthy, within a comparatively short period has assumed a prominent position among the important textile fibers. The increase in the world's supply of raw silk, from a total of approximately 45,000,000 pounds in 1900 to 77,000,000 pounds in 1919, tells graphically the story of the growing popularity of the graceful fabrics obtained from it.

Asia and southern Europe are the sources of the world's raw silk supply. The chief silk-producing countries of the world are China, Japan, Italy, the Mediterranean coastlands of eastern Europe and of Asia Minor and Syria, commonly classed together as the Levant, and France. A small amount of silk is produced also in Spain, India, Austria and Hungary.

The rapid rate of increase in Japanese production, and the surprisingly large proportion which it forms of the world total, are shown in Table A, which gives, by principal countries, world production of raw silk from 1910 to 1921. Amounts are for fiscal years ending June 30, except in the case of Japan, where production figures are available for the calendar year only.

Japan's raw silk output reached its peak in 1919 when it formed more than two-thirds of the world's supply for that year, and showed a gain of about 23,000,000 pounds over the 1910–14 average. Because of world-wide condi-

tions of depression, production in 1920 decreased by about 4,000,000 pounds, and reports of silk production in 1921 show a further decline.

TABLE A—WORLD PRODUCTION OF RAW SILK FOR THE YEARS ENDING JUNE 30, 1909, TO 1921

Country	1910–14 (5-yr. aver.)	1915	1916	1917	1918	1919	1920	1921
	(in thousands of pounds)							
Japan[1]	29,318	33,448	37,367	43,962	47,914	52,578	48,230	45,642
China[2]	17,643	12,880	16,475	16,612	15,267	14,474	19,278	12,379
Italy	8,523	8,951	6,349	7,963	6,217	5,942	4,045	7,330
Levant[3]	5,832	3,935	2,293	2,293	2,293	2,293	2,293	1,654
France	990	893	286	485	452	540	397	551
Austria[3]	726	666	331	331	331	331	331	...
Spain	180	161	121	198	154	165	154	177
India[4]	434	110	220	194	243	254	320	110
Total	63,646	61,044	63,442	72,038	72,871	76,577	75,048	67,843

[1]Calendar year.
[2]Exports only.
[3]Production for 1916 to 1920 estimated.
[4]Estimated.

It is known that Chinese silk production is extremely large, but there are no accurate statistics on the subject. Consequently, figures given are for exports only. After 1914 exports underwent an almost steady decline until 1920 when they exceeded the 1910–14 average by about 1,600,000 pounds. The amount of silk exported in the year ending June 30, 1921, however, fell below the pre-war level. The Chinese silk export is affected to a large extent by the price of silver. When this is low, the Chinese exporter appears to be at an advantage, but when silver is high, exports decline, and the slack is taken up by domestic consumption of silk, which is exceedingly elastic. It is estimated that the Chinese ordinarily consume over half of the silk which they produce.

Production in Italy, France and the Levant decreased greatly during the war and has not yet regained its former volume, although the Italian output showed a marked

increase in 1921. Even before the war, production in Italy and France was falling off in spite of governmental bounties. This was due in part to the generally lower price of silk which prevailed and in part to the competition of eastern silks coupled with an increasing difficulty of competing with cheaper labor.

HISTORY OF SILK

Silk was first produced in China. The mention of silk occurs many times in ancient Chinese history, dating back almost to time immemorial. Of the many legendary versions of the beginning of sericulture, perhaps the most interesting is that which attributes its discovery to Hsi-Ling-Shih, the wife of the Emperor W'Hang. This enterprising young empress collected silkworms, fed them, learned how to reel silk from the cocoons, and even to make it into fabrics. For this she was deified, and was known as the "Goddess of Silkworms."

Sericulture became a national industry, but the Chinese kept their method of obtaining silk a secret for over 3,000 years, although they sold woven silk to the Persians, who, without knowing how or from what it was made, carried it to the western nations. No one, on pain of death, was allowed to export silkworm eggs from China. The only form of silk manufacturing in countries other than China was accomplished by unravelling and reweaving silken goods brought from China.

In 289 A. D. four Chinese girls went to Japan and taught the secret of silk making in that country. Sericulture was first brought to India about 300 A. D. by a young Chinese princess, who at the time of her marriage to an Indian potentate carried to her new home silkworm

eggs concealed in her headdress. From India, the industry gradually spread to Persia and central Asia. As late as 500 A. D. silk-making was still unknown in Constantinople. About 550 A. D., during the reign of the Emperor Justinian, two Nestorian monks brought the secret to Constantinople, having concealed silkworm eggs in their staves. Silk was introduced into the remainder of southern Europe largely as a result of wars, the process being taught by prisoners of war.

Sericulture has always been sought as a national asset. The value of the industry is suggested by the fact that during fifteen years in the middle of the last century losses caused by silkworm disease in France and Italy alone have been estimated at more than a half billion dollars. Although climate is an important factor in successful silk production, the overwhelming importance of a plentiful supply of cheap skilled labor becomes evident by a brief survey of the industry. For this purpose, the work may be divided into two general branches: the production of cocoons, and the reeling of silk from the cocoons into skeins of raw silk.

PROCESS OF SILK RAISING

The production of cocoons includes the raising of mulberry trees in order to obtain the leaves as food for the silkworms, the care of the worms from the time they are hatched until the cocoon is spun and the producing of silkworm eggs for further reproduction. In parts of the world where undomesticated silkworms are numerous, much time is spent also in collecting these cocoons. Both in Europe and the East, cocoon production is carried on largely as a home industry by the farming population.

The silkworm known as the Bombyx mori produces the largest amount of the world's silk, as well as the silk of best quality. It has been domesticated for centuries. The cocoons of numerous species of wild silkworms found in Asia are also used, the silk being classed under the general name of tussah. The egg of the silk moth is about the size of the head of a small pin. Hatching is done artificially in order that it may be simultaneous. The worms are kept on trays for convenience in handling and require a great deal of attention. As the worms must have an even, mild temperature and plenty of ventilation, frequently at this period the farmer and his family move out into the courtyard, giving up the entire house to them. Fresh mulberry leaves must be supplied to the worms as soon as the old ones are eaten. These leaves are carefully selected, as the quality of the silk is directly affected by the kind of food consumed. The exacting work of cocoon production yields very little profit. Women who care for the worms from daylight until night earned, before the war, only six or seven cents a day in Italy; and in Japan and China the return for this labor was sometimes as low as two or three cents. Wages have risen since that time but are still low as compared with compensation received for similar types of work in many other parts of the world.

In spite of constant care, silkworms are subject to several diseases. In Italy and France, and to a lesser extent in Japan, sericulture is highly specialized work. In Italy, particularly, it is said that the rearing of silkworms is as well developed an industry as is the breeding of fine horses in other countries. The Chinese, however, lose large numbers of worms each year through unscientific treatment.

In a little over a month after hatching, having attained its full growth of about three and one-half inches in length and one-quarter inch in thickness, the worm begins the spinning of its cocoon. The silk fluid, in the form of a clear mucilage, is expressed from the underlip in two strands, which harden in the air, and unite to form the silk filament. In about three days the cocoon is completed. It is tough, strong and compact, oval in form and about one to one and one-half inches long, with walls about one sixty-fourth of an inch thick of firm, continuous thread. Within a fortnight after spinning the cocoon, the worm, which in the meantime has changed into a chrysalis, emerges as a moth. The cycle from first to last, including all transformations, is less than sixty days. The escape of the moth from the cocoon breaks so many threads that the cocoons are ruined for reeling, or the unwinding of the silk filament. Consequently, when a few days old, all the cocoons except those intended for reproduction are placed in heating ovens to stifle the chrysalides. After this the cocoons are thoroughly dried out, losing two-thirds of their weight, and the reeling may then be done at any future time.

REELING SILK INTO SKEINS

After the cocoons have been carefully sorted, according to size, etc., they are ready to be reeled. Reeling is a slow, tedious process. To obtain one pound of raw silk about four pounds of dried cocoons, equal to from 2,500 to 3,000 cocoons, must be reeled, and so delicate is the silk filament that a number of cocoons must be reeled together to make the strand of raw silk strong enough for any commercial purpose. As a rule, filaments from five or six

cocoons are combined, but the number varies from three to twelve or more, according to the quality of silk and the size of thread desired. The cocoons which are to be reeled together are put into a basin of hot water, in order to soften the natural gum with which the filaments are fastened together. The outer layers of loose, broken filaments are removed by brushing the cocoons with a brush of twigs as they float in the hot water. Then the ends of the reelable filaments, one from each cocoon, are gathered and run on the reel together. The silk filaments are squeezed closely together in reeling and cohere because their natural gum fastens them together. This is assisted either by bringing the thread back and twisting it around itself about two hundred times in a seven-inch spiral before it passes to the reel, or by twisting the threads from the cocoons in two different basins around each other before they are passed on to their respective reels.

The best raw silks are produced in steam filatures or reeling mills operated by power, but a number of Asiatic filatures still use hand power. Many years ago, the reeling of silk was entirely a home industry in both China and Japan, but the Japanese were quick to copy European filatures and methods of reeling, which enables them to produce raw silks more regular in size and with fewer imperfections than can be reeled by the native method. China also has a large number of steam filatures of modern character.

Reeling involves considerable skill. It takes a girl many years to become expert in this art, yet in Italy before the war the reeling girls were paid only about thirty cents a day at the most, and in the East the wage scale was

much lower. It thus becomes evident that if compensation for all the hand labor involved, even in the most modern methods of raw silk production, were paid according to the high wage scale of the United States, the price of the finished article would be raised to so high a point as greatly to restrict the market.

In China, much silk is still reeled in the homes by primitive appliances. There, even very young children are pressed into service and sit for hours, turning a little handle, unwinding silk from the cocoons. Chinese "tsatlees" are reeled by hand from domesticated cocoons, which are not stifled. As the reeling must be done very rapidly, before the moth emerges, such silks are necessarily very irregular, although they have a wonderful sheen and are very "nervy" or elastic. It is necessary for most of this hand-reeled silk to be re-reeled before it is suitable for commercial use.

In Japan the filatures control the silk culture. They distribute the eggs, keep a general supervision over methods employed and purchase the cocoons. In France and Italy still more careful attention is given to the industry. In France the raising of cocoons is carried on by peasants in the southern part of the country. Marseilles is the greatest French cocoon market and the second largest market for cocoons in Europe, the first being Milan.

In addition to the silk reeled from cocoons produced within their respective countries, Italy and France, particularly Italy, reel silk from cocoons produced in other parts of Europe and in the Levant. Italy normally imported about 10,000,000 pounds of foreign cocoons, and France from 4,000,000 to 5,000,000. Japan imports about 2,000,000 pounds of cocoons, principally from China.

MARKETING RAW SILK

Raw silk is sold in bales which vary in weight according to the country in which the silk is produced, Japanese and Shanghai bales weighing 133⅓ pounds, Canton bales 106⅔ pounds and European bales 220½ pounds. The Asiatic bales are made up of books, or bundles of silk, each containing a number of skeins.

Eastern silks are graded according to a somewhat shifting classification. There is no fixed standard as in cotton and wool. Consequently, as the crops vary from season to season, the higher grades of one season may be no better than the poorer grades of the next season. Each filature usually produces a number of grades of silk which are sold under various "chops" or labels. In addition to these original or market chops, a number of private chops are used by the silk importer in order to insure to his customers that under a certain chop they shall always obtain an unchanging quality of silk. This could not be insured under the original chop owing to the shifting classification. Unfortunately, the use of private chops is sometimes abused to disguise the real quality of silk, and to dispose of a poorer kind under the label of a better grade.

European silks are more systematically classified than are eastern silks. However, the Japanese Raw Silk Mission during its visit to the United States stated that a committee of fifteen had been appointed in Japan to study the subject of classification.

CONDITIONING SILK

Under normal conditions, water makes up about 10 per cent. of the weight of raw silk, but at times the per-

centage is higher. As silk is purchased by the pound, it is obviously essential to know just how much of this weight is water. To solve the difficulty the silk is put through a process called conditioning. This consists in determining the absolute dry weight, to which is added 11 per cent., the total being the conditioned weight, that is, the weight it should be if in its normal condition. Most of the large cities of the world where much raw silk is handled have conditioning houses. Besides conditioning, these establishments make other tests for various purposes, such as ascertaining the boil-off, that is, the percentage of weight lost in degumming silk, and tests for size, tenacity, elasticity, etc.

For very many years past, European silk manufacturers have made a practice of having all their silk conditioned, finding it far more economical than to risk paying for an undue proportion of moisture. The usage is not as general in the United States, but is growing in an encouraging manner. In the year ending June 30, 1922, only 6,746,000 pounds of silk were conditioned in this country against 27,758,000 pounds in Europe, the latter total being abnormally low as a result of the war.

WASTE SILK

While raw silk forms the principal material used in silk manufacturing, waste silk is also an important factor in the industry. Waste silk is unreelable material, such as the coarse and broken outer layers of the cocoon and the inner layers which are too attenuated for reeling. Under this heading are also classed the webby material produced by the worm before spinning its cocoon, waste made in reeling, pierced and otherwise unreelable cocoons, and

waste produced in throwing and manufacturing. This material, which, unlike raw silk, is not in a continuous length, must be made into spun silk yarn by a process similar to that used in the spinning of cotton and flax.

Waste has mixed with it, to a greater or lesser degree, a considerable amount of foreign matter. Chinese silk waste is particularly poor in this respect, owing to the fact that so large a part of the reeling is done at home on the dirt floors. It is said that the poorest grades of waste yield only from 25 to 30 per cent. of spun silk compared with a yield of from 55 to 60 per cent. from better grades. In addition to this disadvantage, the use of the poorer grades of waste, as well as of raw silk, involves a greater amount of time and labor than is needed when better material is used. For this reason American manufacturers ordinarily find it necessary to employ the better grades of silk, although in Europe poorer grades can sometimes be used to advantage, and Japan and China even find it profitable to utilize silks not marketable in other countries.

One of the most striking developments in the silk business during the war was the expansion of the spun silk industry both in Europe and in America. This was caused largely by the war demand for coarse silk cloth with which to make powder bags for the big guns. The bags are made of silk, as it is essential to use a textile that will burn up quickly and completely, leaving no smouldering remnant. Spun silk cloth was chosen rather than cloth made of raw silk, because of the comparative cheapness of the former. This special demand, however, has ceased with the war, and such fabrications are not likely to be reproduced.

CONSUMPTION OF RAW SILK IN THE UNITED STATES

The United States predominates as a consumer of raw silk, consumption during recent years having averaged nearly half of the known world supply. This consumption is entirely dependent upon imports. Table B shows imports of raw silk into the United States, by principal countries of origin, from 1910 to date. Japan is regularly our greatest source of raw silk. Of the total amount imported in 1921 about 70 per cent. came from Japan, about 20 per cent. from China, and less than 10 per cent. from the rest of the world.

TABLE B—IMPORTS OF RAW SILK INTO THE UNITED STATES BY PRINCIPAL COUNTRIES FOR THE FISCAL YEARS FROM 1910 TO 1917 AND THE CALENDAR YEARS 1918 TO 1921

Country	1910–14 (5-yr. aver.)	1915	1916	1917	1918	1919	1920	1921
	(in thousands of pounds)							
Japan	15,592	18,217	22,915	26,342	27,075	33,727	22,904	31,704
China	5,134	5,097	7,420	7,007	5,751	9,099	5,932	9,587
Italy	2,605	2,611	2,546	467	6	1,866	1,111	3,085
France	230	50	127	36	4	50	33	686
Other countries	238	56	63	17	29	75	78	293
Total	23,799	26,031	33,071	33,869	32,865	44,817	30,058	45,355
Reëxports	127	179	197	504	554	487	799	484
Net imports	23,672	25,852	32,874	33,365	32,311	44,330	29,259	44,871

Formerly, European silks were used in this country for the better grade of manufactured products, but Japanese silks have improved to such an extent that they may now be employed in any kind of work. Japan imported French and Italian seed, reproduced it in considerable quantities, and obtains from these worms a yellow silk which has greatly facilitated the replacement of European silks in the American market. Even in its home market the French reeling industry has for some time felt the competition of the more cheaply produced eastern raws

and Italy is also somewhat affected, although to a lesser degree. Table C shows the distribution of Japanese exports of raw silk from 1909 to 1913 and from 1919 to 1921.

TABLE C—EXPORTS OF RAW SILK FROM JAPAN BY PRINCIPAL COUNTRIES OF DESTINATION FROM 1909 TO 1913 AND IN 1919, 1920 AND 1921

Country	1909-13 (5-yr. aver.)	1919	1920	1921
	(in thousands of pounds)			
United States	14,785	36,416	19,448	32,761
France	3,506	1,102	3,283	1,798
Italy	2,264	25	6	...
Russia	377	[1]	[1]	[1]
United Kingdom	46	209	254	71
Other countries	209	109	116	30
Total	21,187	37,861	23,107	34,660

[1]Not reported separately.

The Japanese manner of winding raw silk into skeins is well adapted to American needs. In making the skeins, the raw silk is crossed in a diamond shaped formation, known as Grant reeling, which greatly facilitates manufacturing processes. Some Italian silk reelers have not yet realized fully the importance of having their skeins made up in this fashion, and this has acted against them to some extent in the American market.

OTHER CONSUMING COUNTRIES

Table D shows the amount of raw silk available for consumption in the principal silk manufacturing countries of the world from 1909 to 1913, and in 1919, 1920 and 1921. In almost every instance the figures shown practically coincide with consumption. The term consumption is here used to indicate the amount of silk used in the factories of each respective country, regardless of whether or not the finished articles were consumed within that country. In the case of Japan, although figures for 1919 are

probably not appreciably larger than consumption in that year, figures for 1920 are rendered abnormally high by the presence of huge stocks of raw silk which began to accumulate in Yokohama after the break in the market early in that year. This large amount of 26 million pounds, therefore, does not represent Japanese consumption, which in all probability, like that of every other country except Belgium and Switzerland, declined in 1920 to a point below the level of 1919. It must not be overlooked, however, that the amount of raw silk consumed in Japanese factories has increased tremendously since pre-war years, and that the Japanese silk manufacturing industry has grown at a more rapid rate during that period than that of any other country.

TABLE D—RAW SILK AVAILABLE FOR CONSUMPTION IN PRINCIPAL SILK MANUFACTURING COUNTRIES FROM 1909 TO 1913 AND IN 1919, 1920 AND 1921

Country	1909–13 (5-yr. aver.)	1919	1920	1921
	(in thousands of pounds)			
United States	22,632	44,329	29,259	44,871
United Kingdom	962	1,160	946	378
France	12,684	11,210	8,832	5,493
Italy	4,658	3,757	3,407	2,469
Switzerland[1]	1,105	853	973	655
Belgium[1]	1,090	227	1,106	76
Japan	7,117	17,314	26,008[2]	12,566
Germany[1]	8,713	[3]	2,246	2,549[4]

[1]Net imports. Production negligible and figures not available.
[2]Includes a small amount of reëxported silk.
[3]Not available.
[4]Eight months.

In the United States, as well as in Japan, figures for the amount of raw silk available for consumption in 1920 exceeded actual consumption by a greater amount than usual, although in this case the surplus was not so large.

Chinese raw silk consumption cannot be determined with any exactness, but it is probable that it is second to that of the United States. It has been estimated that in the five years preceding the war Chinese annual consumption was about 21,000,000 pounds.

MANUFACTURE OF SILK

The manufacture of silk goods is divided into two main divisions, the manufacture of silk yarns, and the manufacture of finished silk products such as woven fabrics, braids and silk threads. There are two kinds of silk yarns: spun silk yarns, made by spinning waste silk, and thrown silk yarns, made from raw silks. As raw silk threads are composed of several filaments fastened together with natural gum, they would become matted and unworkable if cleaned and dyed in that state. Consequently, all raw silk that is to be skein-dyed is first thrown, or twisted. Not only is the silk twisted in throwing, but it is often doubled, twisted, and combined again as often as is necessary for the special use to which it is to be put. Thrown silk yarns are of three kinds, namely, singles, organzine and tram. Singles are the single raw silk thread, either twisted or not; organzine is a heavier yarn, intended to be used as warp, by which is meant the strong threads which run lengthwise in the silk cloth; tram, the third kind of thrown silk yarn, is commonly used for weft or filling, that is, the threads which run crosswise in the goods.

Silk yarns are ordinarily dyed in the skein before being woven into cloth. The preparatory step to dyeing thrown silk yarns is "boiling off," a process of which the name is descriptive. This frees the yarn of the natural gum which

made it lustreless, and turns it out in skeins of brilliant, creamy white. The difference in the weight which various silks lose in boiling off is an important factor to be considered in the purchase of raw silks. It is said that the boil-off of good Japan silk is comparatively small. In the case of spun silk yarn, gum is removed from the waste before the yarn is spun.

If the silk is to be "pure dye," it is put through the coloring process, and, after drying, is ready for the final processes of manufacture. Before being put into the dye, however, yarn-dyed silk is usually "weighted." This means that it is dipped into a liquid solution of some substances which the silk absorbs and retains, thus adding to its weight. At times various weighting agents, such as sugar, tannins of different sorts and salts of several metals, have been employed. If not carried to extremes, weighting does no injury to the ultimate consumer, as it makes possible the production of serviceable and attractive materials at much lower cost. On the other hand, if weighting is not skillfully done, or is overdone, the wearing qualities of the silk are apt to be very poor. When goods are to be piece-dyed, the gum is boiled out after the cloth is woven. Then the cloth is dyed, usually without any weighting.

Many mills do not include the whole process of manufacture in their work. It is a frequent practice for a mill to buy the raw silk, and to send it out to an independent throwing firm, to be thrown on a commission basis. In the same manner, dyeing is often done by a special dyeing firm.

The character and extent of the international trade in silk manufactures are indicated at the end of the chapter in

tables which show in detail the exports of silk products from the eight principal silk manufacturing countries, from 1909 to 1913 and for the most recent year for which data are available.

FRENCH SILK INDUSTRY

France, under normal conditions, is the foremost exporter of manufactures of silk, and the quality of French exports is very high. When Germany and Switzerland began to flood the market with a cheaper grade of silk goods, the only means by which it was possible for French manufacturers to hold their supremacy was by maintaining their standard of excellence. The French silk industry is very closely concentrated. The weaving of piece goods is located principally in the environs of Lyons, but the manufacture of heavy satins and pile fabrics is carried on at St. Etienne, which city is also the centre of the ribbon industry. Among the fabrics produced by French manufacturers are many richly embroidered silks, and brocades woven with gold and silver threads. Much of this material finds a ready sale in eastern markets, but the United States also is a large purchaser of novelties not ordinarily made in this country. Because of the novel nature of much of the product, the French silk trade is particularly dependent upon fashion, and is therefore subject to serious fluctuations.

JAPANESE MANUFACTURES

The principal silk fabric manufactured in Japan is the famous "habutae." The name "habutae" means "soft as down." It is woven in the natural gum from raw silk which has not first been thrown or dyed. There are two

classes of habutae, plain and figured, but the former is in by far the larger amount. The Japanese government has a system of inspection of habutae, for the purpose of prohibiting the exportation of any of this cloth that is not up to the standard. Low labor costs enable Japanese manufacturers to make habutae so cheaply that they are able to export large quantities at low prices. Some of the cheaper silks that are exported from France are in reality Japanese habutae, imported at an extremely low price, dyed, printed and shipped out as French cloth. In the United States as well, this material offers sharp competition to American fabrics of the same grade.

In addition to the large amounts of habutae, Japan produces steadily increasing amounts of crêpes, satins and a great variety of piece-dyed, printed and jacquard goods. Sales of some of these materials in the markets of the United States and Europe have been somewhat hampered by the fact that colors and designs were not well suited to western styles. This difficulty, however, is gradually being overcome.

Silk yarns have formed the largest share of the product of Italian silk factories, and large quantities are exported each year. Fabrics of very fine quality are also produced and it is reported that since the war the number of weaving establishments has somewhat increased.

Chinese production of manufactured silk goods consists mainly of pongees, woven in the gum from wild tussah silk. They are sold undyed, and are of the original tussah brown which cannot be bleached. Although little progress in methods has been made, the Chinese skill in silk manufacturing is almost as old as the discovery of sericulture. It is said that there is hardly any weave used in

western countries to-day that was not known in Japan and China hundreds of years ago.

PRODUCTION IN THE UNITED STATES

Exports of silk goods from the United States are small as compared with those from France, but the amount of silk goods produced in the factories of this country exceeds in volume the output of any other country in the world. Table E shows the growth made by the American silk industry since 1904. Although large-scale production of staple fabrics and articles is the leading characteristic of the industry, practically every variety of silk goods is produced in this country, with the exception of certain specialties made by France and other European countries. Many of these fancy goods are made on the small looms that still exist in the homes of French, Swiss and German weavers, and the return for this work is very small. In the United States the manufacture of such goods at a reasonable price would require the use of expensive machinery, the cost of which would not be justified by the limited market and fluctuating demand for the product.

TABLE E—STATISTICS OF THE SILK MANUFACTURING INDUSTRY IN THE UNITED STATES, 1904 TO 1919

	1904	1909	1914	1919
Number of establishments	624	852	902	1,369
Persons engaged in the industry	84,153	105,238	115,571	126,782
Broad looms	50,252	64,836	73,504	87,215
Ribbon looms	9,523	10,570	11,554	9,223
Producing spindles	1,197,403	1,777,962	2,159,271	2,669,459
Capital invested	$109,556,621	$152,158,002	$210,071,679	$532,732,163
Wages and salaries	$ 31,510,213	$ 46,097,364	$ 57,615,374	$134,597,292
Total value of production	$133,288,072	$196,911,667	$254,011,257	$688,469,523

In 1919 the largest number of silk manufacturing establishments in any one state was in New Jersey. Distribution by states according to value of output was as follows:

State	Per cent. of total products of United States.
Pennsylvania	33.6
New Jersey	31.2
New York	11.9
Connecticut	9.8
Massachusetts	4.9
Rhode Island	3.9
Other states	4.7
Total	100.0

CONSUMPTION IN THE UNITED STATES

Of the $688,000,000 worth of silk goods produced in the United States in 1919, 97 per cent. was consumed at home, and this is not an unusual proportion. In addition to consuming so large a share of domestic manufactures, the United States imports from $25,000,000 to $75,000,000 worth of foreign silk products a year. Table F shows by principal countries of origin, the value of manufactured silks imported into the United States from 1909 to 1921. Under normal conditions, nearly half of the imports of manufactured silks come from France. From Germany and Switzerland are imported large quantities of spun silk

TABLE F—IMPORTS OF SILK MANUFACTURES INTO THE UNITED STATES BY PRINCIPAL COUNTRIES FOR THE FISCAL YEARS 1910 TO 1917 AND CALENDAR YEARS 1918 TO 1921

Country	1910–14 (5-yr. aver.)	1915	1916	1917	1918	1919	1920	1921
	(in thousands of dollars)							
France	$14,662	$11,286	$16,865	$17,240	$6,596	$13,689	$19,492	$15,517
Germany	4,392	2,654	187	[1]	...	20	1,716	1,032
Switzerland	3,433	2,556	2,830	3,883	3,548	4,393	9,402	3,805
Japan	3,211	4,908	6,760	11,569	14,698	31,813	35,359	21,213
United Kingdom	2,647	1,991	3,429	3,765	1,549	2,993	4,793	2,756
Italy	798	1,022	843	1,870	655	657	1,654	1,335
China	247	450	896	1,765	1,098	786	1,765	1,961
Other countries	480	176	102	231	311	325	1,239	630
Total	$29,870	$25,043	$31,912	$40,323	$28,455	$54,676	$75,420	$48,249

[1]Less than $1,000.

yarn. From Switzerland we buy also a fine gauze-like fabric known as bolting cloth. It is made especially for use in flour mills, and is not manufactured in this country.

The enormous consumption of silk goods in the United States was greatly stimulated in the period of lavish spending that followed the war. This, combined with the shortage of European raw silk, was the principal factor in creating a demand which at the time appeared greatly to exceed world supplies. The resultant effect upon prices is shown in Table G which outlines the price movement of Italian and Japanese silks in the New York market from 1913 to June, 1922.

The high price level which has prevailed in the raw silk market during the greater part of the post-war period has caused many people to study the possibilities for increasing world supplies. Japan has shown what increases can be made with proper climate and plenty of cheap labor. With the silk industry more scientifically and systematically organized, there should be almost no limit to the amount of raw silk that China could give to the world. In England much is being written with regard to developing the sericultural industry in India in order to fill the demand of European manufacturers.

Italian silk production could be increased by raising three crops a year in the southern part of the country instead of the present single crop. One obstacle to silk raising in southern Italy is the lack of sufficient housing space for the worms, Italian peasant quarters being as a rule very small and congested. This could be overcome, however, by the construction of cheap sheds capable of being heated.

Table G—Trend of Raw Silk Prices in the New York Market in 1913 and from 1919 to June, 1922

(Prices are for date nearest the fifteenth of the month)

Year and month	Italian Extra Classical	Japan Filature No. 1—Shinshiu	China Steam Filature Best No. 1
	(dollars per pound)		
1913			
January	$ 3.80	$ 3.50	$ 4.10
April	3.92	3.53	4.20
July	4.30	3.63	4.45
October	4.60	3.95	4.80
1919			
January	[1]	6.45	7.35
April	[1]	6.45	7.05
July	[1]	9.60	10.10
October	11.20	10.25	11.35
1920			
January	15.45	16.25	16.20
April	13.05	11.70	13.75
July	8.30	6.50	8.25
October	7.40	6.40	7.60
1921			
January	5.75	5.85	6.05
February	5.80	5.60	6.20
March	5.90	5.75	6.20
April	6.75	6.05	6.70
May	6.25	5.35	6.45
June	6.00	6.00	6.55
July	6.15	5.90	6.65
August	6.20	5.69	6.35
September	6.30	5.87	6.60
October	6.70	6.05	6.90
November	6.90	6.50	7.00
December	8.00	7.50	8.00
1922			
January	8.30	7.90	8.40
February	8.05	6.65	7.80
March	7.30	6.30	7.50
April	7.15	6.25	7.25
May	7.90	7.00	7.95
June	8.50	7.35	8.20

[1]Nominal.

Because of large stocks and lack of demand, the tendency during 1921 was to decrease silk production. In Japan, particularly, an attempt was made to decrease output. Italian raw silks were not so much affected, because the position of exchange made it possible to sell Italian silks in the United States at a point below the price level of eastern raws. With improvement in 1922 consumption has increased. It is an undeniable fact that silk has become a necessary commodity, and one for which in normal times there will continue to be a steady demand.

EXPORTS OF MANUFACTURED SILKS FROM PRINCIPAL SILK-MANUFACTURING COUNTRIES

	Quantity (thousands of yards)		Value (thousands of dollars)	
	1909–1913(a) Average	1921(b)	1909–1913(a) Average	1921(b)
I. UNITED STATES				
Dress goods	(c)	3,077	(c)	3,338
Wearing apparel	(c)	(c)	(c)	3,612
All other manufactures	(c)	(c)	(c)	2,722
Total	(c)	(c)	1,574	9,672

(a) Fiscal years ending June 30.
(b) Calendar year.
(c) Not available.

	1909–1913 Average	1921	1909–1913 Average	1921
	(thousands of lbs.)		(thousands of francs)	
II. FRANCE				
Thrown silk yarn	2,879	1,175	49,986	78,649
Spun silk yarn	2,269	1,569	15,821	56,388
Silk thread and embroidery silk	53	175	1,044	10,416
Fabrics of silk or waste silk	5,616	5,064	178,394	595,686
Gauze or crêpe of silk	11	114	525	11,937
Silk tulle	78	415	4,064	43,271
Velvet and plush	54	241	1,830	23,525
Fabrics of waste silk for upholstering	3	55	84	5,274
Silk muslin, grenadine, etc.	18	33	720	2,913
Knit goods	123	325	7,561	35,076
Passementerie	196	1,173	3,344	51,893
Embroideries on silk background	5	39	628	32,740
Laces of silk or waste silk	431	169	19,912	25,964
Ribbons of silk or waste silk	1,504	1,708	48,333	219,859
Silk fabrics with gold or silver thread	3,653	3,262	56,685	296,907

III. Belgium	1909–1913 Average (thousands of lbs.)	1921 (thousands of lbs.)	1909–1913 Average (thousands of francs)	1921 (thousands of francs)
Silk yarns	3,381	2,883	26,519	50,365
Thread and embroidery yarn	(a)	404	(a)	7,292
Ribbon and trimmings	3	5	32	285
Tulles, laces and blonds	4	1	368	214
Knit goods	(b)	18	12	712
Other silk fabrics	28	122	341	5,060

(a) Not available.
(b) Less than 1,000 lbs.

IV. Italy	1909–1913 Average (thousands of lbs.)	1921 (thousands of lbs.)	1909–1913 Average (thousands of lire)	1921 (thousands of lire)
Thrown silk yarn	7,786	5,981	177,678	916,750
Spun silk yarn	2,469	1,353	25,888	73,738
Sewing and embroidery silk	80	99	1,773	6,616
Fabrics of silk or silk waste	3,047	2,419	81,476	299,798
Velvet and plush	7	26	303	3,020
Knit goods	1	14	23	2,188
Tulles and laces	3	394	170	64,699
Trimming and buttons	41	83	795	5,491
Fabrics of silk containing metal threads	3	11	197	2,125
Sewn articles	184	139	11,969	26,772
Galloons and ribbons	226	105	5,745	8,469

(a) Less than 1,000 lbs.

V. Switzerland	1909–1913 Average (thousands of lbs.)	1921 (thousands of lbs.)	1909–1913 Average (thousands of francs)	1921 (thousands of francs)
Thrown silk yarn	2,588	750	58,017	28,841
Spun silk yarn	2,697	1,698	28,146	29,039
Silk thread and embroidery silk	218	178	3,302	5,496
Bolting cloth	69	65	5,078	10,299
Other articles of silk, waste silk and artificial silk, in the piece	4,495	3,390	103,396	170,152
Fabrics of silk, waste silk and artificial silk, cut up and hemmed	93	17	2,347	968
Ribbons	1,488	1,078	41,217	59,862
Passementerie	4	4	96	99
Embroideries	73	7	4,687	1,044
Laces	(a)	(a)	35	18
Table covers and bedspreads	1	...	6	...

(a) Less than 1,000 lbs.

VI. Germany	1909–1913 Average (thousands of lbs)	1920 (thousands of lbs)	1909–1913 Average (thousands of marks)	1920 (thousands of marks)
Thrown silk yarn	1,387	...	19,872	...
Spun silk yarn	1,114	181	6,781	54,080
Thread	572	266	5,957	121,305
Silk, waste silk or artificial silk combined with metal threads	35	...	292	...
Upholstery fabrics	85	18	1,544	7,815
Fabrics of velvet and plush of silk	1,741	2,077	16,745	851,681
Fabrics of silk	6,322		67,130	
Ribbons	2,068	909	25,156	390,944
Tulle	13		257	
Bolting cloth	1	68	57	34,408
Gauze, crêpe and similar fabrics of silk	52		659	
Knitted silk	525	552	8,036	222,895
Lace & lace goods of silk	230	90	3,875	42,774
Embroideries on silk	206		3,297	
Silk trimmings, buttons, etc.	11,957	2,377	60,491	305,276

VII. United Kingdom	1909–1913 Average (thousands of lbs.)	1921	1909–1913 Average (thousands of £ sterling)	1921
Thrown silk yarn	65	(a)	55	1
Spun silk yarn	1,217	235	403	279
Broadstuffs entirely of silk(b)	4,661	1,515	455	459
Broadstuffs silk combined with other materials(b)	6,783	1,733	724	754
Laces, entirely of silk	(c)	(c)	79	69
Laces, silk combined with other materials	(c)	(c)	13	23
Ribbons, entirely of silk	(c)	(c)	15	59
Ribbons, silk combined with other materials	(c)	(c)	13	17
Other manufactures	(c)	(c)	426	623

(a) Less than 1,000 pounds.
(b) Thousands of yards.
(c) Not available.

VIII. Japan	1909–1913 Average (thousands of units)	1921	1909–1913 Average (thousands of yen)	1921
Spun silk yarn (lbs.)	419	271	1,280	2,091
Silk piece goods; habutae (lbs.)	3,070	2,701	29,388	43,558
Kaiki, including cotton mixture (yds.)	774	65	269	76
Satins (yds.)	2,236	7,291	1,107	7,138
Taffetas (yds.)	1,353	655	917	758
Chiffon (yds.)	1,030(a)	229	411	157
Silk and cotton pongee (yds.)	(b)	27,134	(b)	23,802
Crêpes (yds.)	377	6,731	563	10,709
All other silk piece goods (pieces)	95	(b)	630	3,739
Silk handkerchiefs (doz.)	1,481	961	4,551	3,186
Silk nightgowns (no.)	158	35	746	240
Silk shawls (no.)	393	(b)	252	(b)
Silk underwear (doz.)	5	9	114	368

(a) Two-year average.
(b) Not available.

SUGAR

SOMEWHAT more than a thousand years ago the western world learned from the East the use of crystallized substances from the juice of sugar cane and the era of the Crusades marked the beginning of trade in sugar between Europe and the Levant. Hundreds of years later the need for a substitute for cane sugar led to the production of sugar from the juice of beet roots. Except for a few sweetening substances such as honey, the West subsisted without sugar until medieval times, yet to-day more than 16,000,000 tons of sugar are distributed annually in the world's markets, and sugar has become one of the most valuable of foods.

Practically all the sugar produced is used for food, either directly or in manufactured food products. In the United States per capita consumption averages about 85 pounds of sugar a year, and before the war British consumption was somewhat above this figure. In Australia the rate of consumption is more than 100 pounds a year. Per capita consumption of sugar is far smaller, however, in most European countries and in some parts of the world little or none is used.

The dry, white granulated sugar of to-day is far removed from the dark, moist mass or the hard loaf which formerly were in everyday use. War conditions brought home the fact that sugars vary greatly in appearance and quality. Coarse yellowish sugars from Java and other countries were

an unwelcome substitute for the perfect product to which American consumers had been accustomed. The purity and uniformity of white granulated sugar are the result of years of experiment and scientific development. Chemically, sugars are carbohydrates, combinations of carbon, hydrogen and oxygen. Cane and beet sugars when fully refined are pure sucrose, differing in composition from glucose and other forms of sugar found in plants. From a dietary standpoint refined sugar is a highly concentrated food, containing practically no waste and consisting exclusively of energy-producing elements.

CANE AND BEET SUGAR

Sugar cane is believed to have originated in India or some other part of eastern tropical Asia. Knowledge of the cane plant was acquired from India by the Chinese, as is shown in Chinese writings of the eighth century B. C. Solid sugar was first known in the East about 600 A. D., so far as historical records show. The Arabs probably were responsible for the introduction of cane culture into Egypt and from there into Spain. However, it was not until after the return of the Crusaders from Palestine, where they found cane plantations, that trade in sugar began to spread throughout western Europe. Cane culture was introduced into the West Indies from Europe soon after the discovery of the New World.

After centuries of cultivation, cane remains a tropical plant, which is grown commercially no farther north than Georgia or southern Spain. Sugar beets are as distinctively natives of the temperate zone, thriving best in western Europe and in the North American continent. The United States, Spain and Australia produce both

sugar cane and beets, but only under widely different conditions. The value of rich tropical lands for the growing of sugar cane and other agricultural products made them eagerly sought by European powers in the period of colonial expansion; yet after rival nations had secured themselves in the possession of East and West Indies, France under Napoleon created the beet sugar industry on European soil in an effort to become independent of foreign supplies. From France and Germany beet culture spread eastward to Russia, southward to Italy, and northward to the Scandinavian countries.

Although beet sugar has so recently entered the field it has proved a vigorous rival of cane sugar. The race between the luxuriant, self-renewing cane of the tropics and the carefully cultivated beet of the temperate zone has been an interesting contest in the past 80 years. The leading place was first won by beet sugar in the season 1882–83. Occasionally after this cane sugar production forged ahead but did not hold the lead. The chief European governments used bounties, drawbacks on exports and other measures to encourage production of beet sugar, which thus was enabled to supersede cane sugar in the British market. The effect on the West Indian industry was disastrous. Finally the principal western European governments agreed, under the terms of the Brussels Convention of 1902, to do away with artificial aid to beet production. Cane sugar soon took the lead. Cane production in 1900–01 was 2,850,000 tons; by 1910–11 it had increased to 8,433,000 tons. The war disrupted beet sugar production so that its output fell from 8,635,000 tons in 1913–14 to 3,255,000 tons in 1919–20. At the same time expansion in the cane sugar industry brought the

crop to 11,914,000 tons in 1919–20. As normal production in Europe is restored the contest will again be active. Total sugar crops of the world at 10-year intervals from 1840 to 1910 and annually thereafter are shown in table A. The proportion of cane and beet sugar is also shown.

TABLE A—SUGAR CROPS OF THE WORLD AND PERCENTAGE OF CANE AND BEET, 1840 TO 1922

Year	Total crop	Cane (in gross tons)	Beet	Percentage of total: Cane	Percentage of total: Beet
1840	1,150,000	1,100,000	50,000	96	4
1850	1,400,000	1,200,000	200,000	86	14
1860	1,899,000	1,510,000	389,000	80	20
1870	2,416,000	1,585,000	831,000	66	34
1880–81	3,659,000	1,911,000	1,748,000	54	46
1890–91	6,265,000	2,555,000	3,710,000	41	59
1900–01	8,800,000	2,850,000	5,950,000	32	68
1910–11	[1]16,994,000	[1]8,433,000	8,561,000	50	50
1911–12	16,064,000	9,175,000	6,889,000	57	43
1912–13	18,209,000	9,290,000	8,919,000	51	49
1913–14	18,436,000	9,801,000	8,635,000	53	47
1914–15	18,483,000	10,177,000	8,306,000	55	45
1915–16	16,882,000	10,627,000	6,255,000	63	37
1916–17	17,105,000	11,332,000	5,773,000	66	34
1917–18	17,415,000	12,408,000	5,007,000	71	29
1918–19	15,841,000	11,960,000	3,881,000	76	24
1919–20	15,169,000	11,914,000	3,255,000	79	21
1920–21	16,682,000	12,006,000	4,676,000	72	28
1921–22	[2]17,423,000	[2]12,446,000	[2]4,977,000	71	29

[1]Estimate of production in British India is included in 1910–11 and later years.
[2]Estimate near close of harvesting season.

THE WORLD'S SUGAR PRODUCTION

Maximum production of sugar was reached in 1914–15 when the world's crop, cane and beet combined, was 18,483,000 tons. Sharp curtailment in the European output of beet sugar during and after the war reduced the total to 15,169,000 tons in 1919–20. Since that year the trend has been upward. Prompt recovery from depression has been a characteristic of the sugar crop.

The limit of the world's output has not been approached. More sugar may be grown by putting additional land under cane or by increasing the yield per acre. Cuba and the Philippines, for example, can extend their cane fields. British India now produces about one ton of sugar to the acre, but by the use of improved methods, output can readily be raised to two or three tons. In the United States, Canada and elsewhere larger areas can be devoted to beet culture, whenever the price of sugar makes it profitable in competition with other crops. Supply can thus be increased whenever there is enlarged demand from consumers who are able to buy sugar.

Labor shortage threatens to become a limiting factor in some localities but as an offset there is the possibility of more widespread use of machinery. Cane cutting and cultivation of beet fields still require considerable hand labor, while machinery has been applied to most of the later processes. Mechanical cane cutting seems not impossible as a number of machines have been designed for that purpose, some of which may eventually prove practicable.

CANE SUGAR PRODUCTION IN CUBA

Cuba is the leading producer and exporter of sugar. After the liberation of the island in 1898, this industry, which is by far the largest in Cuba, was greatly stimulated. The maximum crop under Spanish rule was 1,000,000 tons (1894) but by 1910 this figure was almost doubled and in 1921–22 the record crop of 3,996,000 tons was made. Cuban crops in 1913–14 and from 1918–19 to 1921–22 are shown with those of other countries in table B on page 196. The area of land suitable for cane which was controlled

by producers in 1920 was estimated at over 4,000,000 acres or about one-seventh of the area of the island. More than half of this acreage is controlled by the "centrals," factories which as a rule are owned by large corporations. The central usually grinds not only the cane produced on its own lands but also some cane purchased from near-by "colonos" who own estates or farms. Of the entire investment in the Cuban sugar industry, estimated at over $950,000,000 in the fall of 1921, two-thirds are believed to be American capital.

Cuba has almost ideal conditions for cane cultivation: a warm climate, plenty of moisture, and rich soil, much of which is underlaid with limestone. Future development of the industry will probably be greater in the east, where the land has not been cropped for so long a time and more virgin soil is still available, than in the west. The yield per acre is somewhat higher in the east and production costs consequently lower. Native labor is supplemented in times of high wages by immigration from Spain and from near-by islands.

The cane plant belongs to the grass family and grows from 8 to 24 feet in height. There are several varieties, but much remains to be done in the development of new strains. New cane is grown from sections of stalk which are planted in the spring or fall and cutting begins nine months or more after planting. Old roots continue to produce new but less abundant growth, called ratoon crops. In Cuba it is often profitable to allow the cane to ratoon for ten years. Only simple cultivation and a moderate use of fertilizers are required. Cuban agricultural methods are not intensive, but they have proved adequate under present conditions. Fifteen or twenty

tons of cane to the acre is an average yield, from which somewhat more than two tons of sugar are made. Grinding begins late in November and the greater part is completed in June.

Mechanical methods of handling cane and making sugar are highly developed in Cuba and are typical of progressive methods used in other cane-growing countries. Freshly cut cane is hauled immediately to the central where it is fed to the crusher which breaks and flattens the stalks. It then enters the mill and is passed between heavy rollers to force out the juice. From 12 to 16 per cent. of the weight of the cane consists of sugar, most of which can be extracted, although the maximum sugar content may be higher. The richness of the juice varies under different conditions of growth and maturity.

Cane juice, after having been heated, settled, and filtered, is boiled first in multiple evaporators, then in vacuum pans in which it is almost completely crystallized. Most of the mother liquor or molasses remaining thereafter is driven off in centrifugal machines revolving at high speed. Frequently the crystals are subjected to steam treatment for additional drying. The product is a hard-grained, yellowish-brown raw sugar, practically dry and possessing good keeping qualities, which is sold as 96° centrifugal on the basis of a pure sucrose content of 96 per cent.

The natural market for Cuban raw sugar is the United States and refineries from Boston to Galveston use this grade. Under the reciprocity treaty between the two countries, the United States grants a reduction of 20 per cent. of the duty on all imports from Cuba. The United Kingdom became a large buyer of Cuban sugar during the war, when European beet sugar was cut off. British

imports from Cuba in 1918 increased almost fourfold over 1913, but after the war this trade declined, leaving Cuba with greatly increased crops for which purchasers were needed. Wartime prosperity had led to heavy investments in new and costly installations at centrals. The close of 1921 found Cuba in a serious financial condition with abnormally large stocks of sugar, almost one-third of the year's crop.

The problem of the surplus at the close of 1921 was largely solved by a tremendous buying movement in the United States and unusual European purchases in the first half of 1922. But the Cuban industry has demonstrated its ability to increase production at a more rapid rate than the normal increase of American consumption. It may eventually become necessary for Cuba to dispose of an increasing proportion of its product outside of the United States. As continental beet-growing countries will, in all probability, again supply their own needs with a surplus for export, Europe is only an uncertain market for Cuban sugar. The Orient has been suggested as an outlet, but in this connection a potential increase in production in the tropical areas of Asia, the Philippines, and the Malay Archipelago is not to be disregarded.

OTHER CANE SUGAR PRODUCING COUNTRIES

British India falls far short of its potential importance as a sugar producer. With nearly 3,000,000 acres under cane (1920–21) the country does not supply all of its domestic demand and regularly imports additional sugar, mostly from Java and Mauritius. The sugar crop of 2,500,000 tons or more represents less than the entire cane production, as some cane is used directly for chewing and

other purposes. While information on the Indian crop is inexact owing to the non-commercial character of much of the production, the yield is known to be conspicuously low, averaging just over one ton of sugar to the acre. The bulk of the output is a crude raw sugar called "gur" which satisfies the native population. Efforts are under way to improve the methods of cultivation and increase output.

A remarkable state of development has been reached in the cane sugar industry of Java. The Dutch government and the producers themselves have thoroughly utilized scientific methods of culture and extraction, with brilliant results. Abundant and cheap labor has also been an important factor in success. A crop averaging about 1,500,000 tons is produced and Java is the second largest exporter in the world. "Java white," the characteristic product of the industry, is an incompletely refined sugar especially adapted to the market in British India, where religious prejudice exists against sugars refined with animal charcoal. Other grades made in Java are "browns" and muscovado (raw sugar of a lower grade than centrifugal). British India, Japan and China take the bulk of Java's exports, but in times of high prices, as in 1920, exports to Europe and America are increased at the expense of the Orient.

Cane is grown in many sections of the world other than those mentioned, but on the basis of a total cane sugar production of about 12,000,000 tons a year the crops of Cuba, India and Java, amounting to about 3,900,000 tons, 2,500,000 tons and 1,500,000 tons respectively, constitute nearly two-thirds of the world's supply. Hawaii furnishes the largest item of the remainder, with Porto Rico and Japan (including Formosa) as close competitors. Several

other regions, including Peru, Brazil, the Philippines, Mauritius, Argentina, Australia and Louisiana produce considerable quantities. Most of the larger islands of the West Indies grow enough cane to export at least a small quantity of sugar and in some cases the manufacture of molasses and Jamaica rum adds to the profits of the sugar industry.

The Hawaiian Islands merit special attention as the most advanced development of the cane sugar industry. The highest yield per acre in the world is achieved there through the aid of natural resources, scientific knowledge and organization. In recent years the production of the islands has averaged 4.3 tons of sugar to the acre while individual plantations sometimes produce almost 12 tons to the acre. The cane is said to excel that of any other country in quality. But Hawaii can put little if any new land into cultivation and will have much to fear from the competition of countries where land is cheaper and wages lower. Under the favorable influence of the reciprocity treaty of 1876 with the United States, Hawaiian production made notable gains, reaching 200,000 tons just before annexation by the United States in 1898. The record crop was that of 1914–15, 577,000 tons. Free admission of Hawaiian sugar into the United States insures a market with preference over all foreign sugar, including Cuban.

The Philippines are still far from full development of their sugar industry, and exports remain about the same as under the Spanish régime. Modern factories and equipment have been installed so that centrifugal raw sugar now predominates over muscovado. Exports are divided between the Far East and the United States. In Porto Rico most of the sugar is produced at centrals with

modern methods and machinery. Since the island became an American possession, production has risen from an average of less than 100,000 tons (1900–05) to over 400,000 tons, marketed exclusively in the United States. Philippine and Porto Rican sugars are free of duty.

Louisiana has produced cane sugar since the French colonial period, before 1800, and Texas produces a small crop. The quantity in the two States is not large enough to affect the world market. Although soil and rainfall are suited to cane culture, the growing season is sometimes shortened by frosts, and low yield per acre and high labor costs increase the cost of production. The crop averages about 200,000 tons a year, which is refined and used in the United States. Crops of over 300,000 tons are occasionally made, as in 1911–12 and earlier, but on the showing of the last ten years, Louisiana sugar production is a declining industry.

Refining generally forms a separate branch of the cane sugar industry and is carried on in countries where the market for refined sugar exists. Eastern refineries of the United States use chiefly Cuban raws, filling in with Porto Rican, Philippine, and other grades, while San Francisco handles principally Hawaiian sugars. The British refineries draw their raw cane sugar from all quarters of the world—Cuba, Mauritius, the British West Indies, South America and Java. Filtering through charcoal to remove coloring matter is an essential part of the refining process. Raw sugar yields slightly less than an equal weight of refined owing to the removal of molasses and impurities.

Table B shows cane and beet sugar production by leading countries for 1913–14 and from 1918–19 to 1921–22.

TABLE B—SUGAR CROPS OF PRINCIPAL PRODUCING COUNTRIES

Country	1913–14	1918–19	1919–20	1920–21	1921–22[1]
		(in thousands of gross tons)			
Cane Sugar—					
United States:					
Louisiana.............	261	251	108	151	290
Texas................	7	4	...	6	3
Porto Rico.............	325	363	434	439	385
Hawaiian Islands........	551	539	496	508	490
Virgin Islands of the U. S.	6	9	12	5	5
Cuba..................	2,598	3,972	3,730	3,936	3,996
British West Indies......	136	197	191	143	158
French West Indies......	66	37	42	52	59
San Domingo and Haiti..	106	162	180	191	237
Mexico and Central America	150	98	127	153	157
Argentina..............	280	130	299	202	175
Brazil..................	158	183	177	340	325
Peru	228	294	330	350	325
Other South America....	129	140	118	130	123
British India............	2,292	2,370	3,049	2,448	2,500
Java..................	1,272	1,749	1,336	1,509	1,650
Formosa and Japan......	157	416	283	342	407
Philippine Islands.......	233	195	209	256	276
Australia...............	266	210	162	182	299
Fiji Islands.............	92	66	88	73	65
Mauritius	250	253	236	260	182
Natal, Egypt, and other Africa[2]...............	231	315	301	323	334
Spain..................	7	7	6	7	5
Total Cane Sugar...	9,801	11,960	11,914	12,006	12,446
Beet Sugar—					
Germany...............	2,618	1,351	740	1,153	1,330
Austria and Hungary....	1,683	607	12	48	79
Czechoslovakia..........			494	708	660
Russia and Ukraine......	1,688	337	78	89	49
Poland.................			140	190	225
France.................	717	110	154	305	278
Italy...................	305	108	183	135	200
Spain..................	169	139	82	171	135
Belgium................	229	74	147	243	290
Netherlands.............	229	173	239	316	376
Other Europe...........	330	285	316	314	425
United States...........	655	675	653	969	911
Canada................	12	22	17	35	19
Total Beet Sugar....	8,635	3,881	3,255	4,676	4,977
Grand Total, Cane and Beet	18,436	15,841	15,169	16,682	17,423

[1] Estimates near close of harvesting season.
[2] Including Mozambique and the island of Reunion.

BEET SUGAR

The growth of the beet sugar industry is a striking example of the application of science to agriculture. A German chemist, Andreas Marggraf, made the discovery about 1750 that beets and other vegetables contain sucrose, white beets carrying about 6 per cent. In 1802 one of Marggraf's pupils operated in Silesia the first beet sugar factory in the world. Interest in the new enterprise spread to France and in 1811 Napoleon issued the famous decree by which beet culture and beet sugar manufacture were established in France. A domestic supply was urgently needed as imports from the West Indies were cut off by the British blockade. When the blockade was raised after Napoleon's defeat, cane sugar was again available and all European beet sugar factories suffered temporarily. The new industry revived after a few years, and great progress was made in improving the quality of the root. The maximum sugar content is now between 18 and 21 per cent.

While the beet will grow in a large area in the temperate zone, its chief centers of production are France, Belgium, and the Netherlands, central Germany, Czechoslovakia, and southwestern Russia. Beet culture extends northward to the Scandinavian countries and southward to Spain and Italy. In the United States beets are grown from Ohio to California and as far north as Michigan and Washington. The largest crops are grown in Colorado and California. The sugar beet requires fertile soil, sunlight and moisture without tropical heat, and exceptionally careful cultivation and hand thinning.

The method of manufacture is, in many respects, similar

to that used in cane sugar manufacture, but the juice is extracted by the diffusion process. Thinly sliced beets are placed in large tanks which are then filled with warm water. The sugar held in solution in the cells of the beet passes through the cell walls into the water. This operation is repeated until practically the whole of the sugar content of the beet has been removed. Later steps include saturation, evaporation and crystallization. For the refining process bone black or charcoal may be dispensed with or used to a smaller extent than in cane refining. In the United States most factories carry out all steps from slicing to refining, but in Europe many beet sugar factories turn out raw beet sugar which is later sent to separate refineries or exported. Formerly considerable quantities of raw beet were exported from the Continent to Great Britain for refining at port-side refineries. Beet pulp is used for stock feed, and the molasses by-product, like cane molasses, may be reworked for its sugar content, distilled, or used in cattle feed.

BEET SUGAR PRODUCTION

Most of the world's beet sugar is made in Europe, but since the war the United States has produced more beet sugar than any other single country save Germany. Canada's beet sugar industry is small but thriving, and Australia grows about a thousand acres of beets. Beet culture is also established in China.

The European beet sugar industry reached its maximum production, 8,300,000 tons, in 1912–13 and fell as low as 2,600,000 tons in 1919–20. While there has been steady improvement since that season Europe is thus far unable to supply its own needs. Germany has been, since 1880, the largest producer of beet sugar and still holds first

place although several German beet factories and a considerable area of beet fields were awarded to Poland. Austria retains only a fraction of its former capacity. Czechoslovakia, which fell heir to the greater part of the Austrian beet industry, now occupies second place among European countries and produces sugar for export as well as for home use. Russia as well as Germany lost to Poland. For a time at least Russia cannot export sugar in significant quantities. Poland had 70 factories in operation in 1921, but their output was only 30 per cent. of the pre-war output in the same area. The French industry suffered severely from the destruction of factories, and three years after the Armistice France was still importing more sugar than she exported. Belgium, the Netherlands, Spain and Italy hold practically the same position as before the war. Production of beet sugar by countries for the seasons 1913–14 and from 1918–19 to 1921–22 is included in Table B on page 196.

For many years British refiners of cane sugar waged a determined battle against the continental system of government bounties and other artificial aids to beet sugar production. In some countries the beet sugar industry was permitted to raise the price of sugar exorbitantly in the home market in order to undersell cane sugar in foreign markets. British refineries found their cane sugar business steadily declining and British colonies suffered severely from the depression in the cane sugar market. On the Continent the beet sugar refining interests profited liberally at the cost of consumers and beet growers. The Brussels Sugar Convention was finally signed by all the principal European governments except Russia in 1902 and became effective in 1903. By this agreement the

signatory governments bound themselves to collect countervailing duties on imported sugar on which bounties were paid in the producing country. Accordingly bounty fed sugar from Continental countries could enter the British market only on payment of duties equal to the subventions received from the home government. Practically free competition between cane and beet sugar was soon restored and the immediate result was cheaper sugar for Continental consumers.

In 1920 the Convention came to an end but a revival of state aid to beet sugar is unlikely, both because of the financial difficulties of Continental governments and the probable opposition of consumers. Without such aid the industry is unlikely again to offer severe competition to cane sugar in the world's export markets. Its domestic position, however, is secure, as beet culture serves several purposes in the European agricultural system, such as providing cheap cattle feed and filling a place in an exacting system of crop rotation. In France the use of improved agricultural methods in the devastated regions and the future rebuilding of factories with modern equipment may lead to more economical production.

The American beet sugar industry is a much larger contributor to the sugar market than the Southern cane industry. It was possible to increase beet sugar production 20 per cent. in the crop year following the opening of the war in Europe, but after the entry of the United States into the war some of the increase was lost. The outturn of the crop of 1920–21 showed a remarkable expansion in production which was practically maintained the following year. Efforts to establish the beet sugar industry in the United States began in 1830 and met with

many difficulties. In 1890 only three beet sugar factories were in operation in the United States and their combined capacity was only 10,000 tons a year. Progress has been rapid since that time. In the season 1919–20 there were 106 beet sugar mills in the United States, including those under construction. In 1920 from an area estimated at about 900,000 acres a crop just under 1,000,000 tons was produced. This is far less than the proportionate yield in Europe. Cost of production is high compared with that of Cuban cane sugar. The crop is marketed exclusively in the United States, usually no farther east than Buffalo and Pittsburgh.

Beet sugar crops in the United States for the years 1890, 1900, 1910 and annually thereafter are shown in Table C.

TABLE C—BEET SUGAR CROPS OF THE UNITED STATES, 1890, 1900, AND 1910 to 1922

Year	Crop (gross tons)
1890–91	3,000
1900–01	77,000
1910–11	455,000
1911–12	541,000
1912–13	624,000
1913–14	655,000
1914–15	646,000
1915–16	780,000
1916–17	735,000
1917–18	683,000
1918–19	675,000
1919–20	653,000
1920–21	969,000
1921–22	911,000

DISTRIBUTION IN THE WORLD MARKET

Countries important in the sugar trade may be divided into three groups: first, those which are regularly net exporters; second, those which cannot supply their own needs and are therefore net importers, and third, countries

which produce sugar primarily for their own use and in addition either export or import as circumstances in their own or in the international market require.

Export trade since the war is carried on in large units principally by the cane-producing countries, Cuba, Java, Mauritius, Hawaii, Peru, Brazil, the Philippines, Dominican Republic, and Porto Rico. Other West Indian islands contribute a considerable quantity of sugar. Cuba and Java are the great sources of supply and their combined crops, which formed about 33 per cent. of the world's production in 1920–21 are almost wholly available for export. Hawaii, Porto Rico, the Philippines, and Mauritius regularly devote 80 per cent. or more of their output to export trade.

Prior to the war, Germany, Austria-Hungary, the Netherlands, Belgium and Russia were net exporters of beet sugar. Net exporters of beet sugar in 1920 included Czechoslovakia, Poland, the Netherlands and Belgium. Germany is nearing the point where export trade can be resumed. The prospects of present and former Russian territories are problematical.

The great importing markets are the United States, the United Kingdom, and British India, which rank in the order given. By reason of the large domestic and insular production and the preference granted to Cuban sugar, the American market is not open to other producers save to a very limited extent. The United Kingdom gives preference to sugar from its own possessions which, however, supply very little of the demand. Competition between selling countries, therefore, centers upon the markets of the United Kingdom and India, and their annual purchases of about 1,300,000 tons and 500,000 tons, respectively, represent the great prizes in the international trade.

The import trade of Canada and China is of considerable proportions and Japan has a large import balance after exporting nearly 100,000 tons of sugar annually.

In the pre-war period, France was the outstanding representative of the third group. Its beet production was practically sufficient to meet domestic requirements. In addition, an extensive refining industry handled imported raw sugars, permitting considerable exports of the refined product. Exports and imports were in approximate balance, the net movement in either direction being determined by conditions in the international market. Since the war France has been a net importer, taking as much as 540,000 tons net imports in one year. This is abnormal, and as the domestic crop improves imports are being curtailed. In 1921 the imports were cut down by half and exports were increased.

A general view of the international sugar trade is afforded by Table D which shows average production, consumption, and net imports or exports of the principal countries from 1909 to 1913.

TABLE D—PRODUCTION, CONSUMPTION AND NET IMPORTS AND EXPORTS OF SUGAR BY PRINCIPAL COUNTRIES—AVERAGE FOR 1909 TO 1913

Country	Consumption	Production	Net Imports	Net Exports
	(in thousands of gross tons)			
United States	3,391	788	2,603	...
British India	2,830	2,251	579	...
United Kingdom	1,814	...	1,814	...
Germany	1,467	2,130	...	663
Russia	1,181	1,404	...	223
Austria-Hungary	683	1,417	...	734
France	646	671	...	25
Cuba	200	1,831	...	1,631
Netherlands	117	217	...	100
Java	111	1,299	...	1,188
Porto Rico	31	311	...	280
Hawaii	10	495	...	485

The export situation is indicated in some detail in Table E, which shows the exports in 1913 of practically all sugar-producing countries whose output entered into international trade, as well as their exports in 1919 and 1920, so far as information is available. The table indicates graphically the disruption in European sugar trade occasioned by the war, and the expansion in the exports of most non-European sugar-producing countries.

TABLE E—NET EXPORTS OF SUGAR FROM PRINCIPAL EXPORTING COUNTRIES, 1913, 1919 AND 1920

Country	1913	1919 (in gross tons)	1920
Cuba	2,409,625	3,960,485	[1]3,363,773
Java and Madura	1,257,268	1,832,118	1,481,320
Germany	1,097,066	[3]	[4](84,368)
Austria-Hungary	1,046,774	[3]	[5](58,251)
Czechoslovakia		[1]282,899	[1]259,323
Hawaii[2]	484,452	477,393	460,922
Porto Rico[2]	335,703	314,082	373,890
Mauritius	[1]184,804	[1]298,040	[1]179,581
Philippine Islands	152,870	129,502	175,090
Netherlands	131,167	[4](8,435)	33,483
Peru	[1]140,643	267,734	[1]246,013
Belgium	107,398	[4](26,628)	14,083
Russia	[1]145,018	[3]	[3]
Poland		[6]6,194	10,597
Fiji Islands	94,366	[1]64,348	[1]72,985
British Guiana	87,246	[1]83,140	[1]83,765
France	84,428	[4](540,057)	[4](531,675)
Dominican Republic	[1]77,605	159,414	153,278
Martinique	[1]39,527	[1]7,365	[1]15,907
Trinidad and Tobago	32,230	37,775	47,909
Reunion	[1]38,356	[1]49,179	[1]39,300
Guadeloupe	[1]26,215	[1]17,677	[1]23,243
Barbados	9,774	[1,2]44,797	[1,2]26,346
Brazil	5,139	68,233	107,413
Jamaica	4,428	[1]38,000	[1]36,664

[1]Gross exports.
[2]Fiscal years.
[3]Not available.
[4]Net imports.
[5]Austria alone, net imports.
[6]November and December only.

The direction of exports is determined primarily by location of markets, but may be influenced by political control, tariffs, or trade connections. The fact that Cuba receives tariff preference in the United States makes it advantageous to dispose of as much of the crop as possible in that market. This fact also restricts the sale of West Indian sugars in the United States except for reëxportation after refining. Sugar from British and French West Indian colonies receives preferential tariff treatment from the home governments. Good keeping qualities and the ease with which sugar can be shipped make the sugar trade very flexible. Philippine sugar bears the cost of shipment to New York and sells in competition with Porto Rican. Java sugar is marketed both in the East and in Europe. South American countries such as Argentina and Peru, in which British capital is invested, pay part of their trade balances in sugar shipped to the United Kingdom.

Cuba is secure in the position of foremost exporter of sugar in the world. Distribution of Cuban exports in five pre-war years and from 1918 to 1921 is shown in Table F.

TABLE F—EXPORTS OF RAW SUGAR[1] FROM CUBA, 1909–13, AND 1918 TO 1921

Country	1909–13 (5-yr. aver.)	1918	1919	1920	1921
		(in gross tons)			
United States......	1,672,196	2,246,946	3,116,226	2,514,655	2,118,985
United Kingdom...	85,382	860,647	603,166	[2]661,584	[2]340,800
Other countries....	14,558	93,799	231,538	187,534	130,735
Total.........	1,772,136	3,201,392	3,950,930	3,363,773	2,590,520

[1]There are also small exports and imports of refined sugar.
[2]Includes amounts exported to other European countries.

British India is normally the chief purchaser of Java sugar, but in 1920 exceptional prices in the United States

and Europe attracted increased quantities to the west. Javan exports, however, were not permanently diverted from pre-war markets. Shipments from the crop of 1921 show a return to Eastern markets. Table G shows average annual exports for the fiscal years 1909–13 and exports from 1918 to 1921.

TABLE G—EXPORTS OF SUGAR FROM JAVA BY COUNTRIES

Country	1909–1913 (5-yr. aver.)	1918	1919	1920	1921
			(in gross tons)		
British India and Ceylon[1]	466,823	370,919	355,716	260,479	662,431
Hongkong	194,067	321,589	217,158	158,606	373,536
Port Said and Suez, for orders[2]	168,414	17,788	121,203	306,720	[3]
Japan	148,787	367,978	369,596	151,976	264,392
Straits Settlements, Siam, and French Indo-China	73,570	195,034	94,763	39,948	82,267
Australia and New Zealand	46,843	6,273	112,556	85,892	17,542
United States	29,151	8,103	1,898	245,014	300
China	24,938	19,800	1,955	1,638	33,876
United Kingdom	22,224	73,877	209,264	55,321	10,126
Other countries of Europe	18,427	64,520	272,528	142,669	96,033
Other countries	34,882	68,261	75,624	33,214	116,168
Total	1,228,126	1,514,142	1,832,261	1,481,477	1,656,671

[1] Including exports to Pondicherry.
[2] Chiefly to Europe.
[3] Not separately reported.

Total consumption of sugar was at a low ebb after the war. Reduced purchasing power in many consuming markets restricted the effective demand, and disorganization of industry in Europe curbed production. Although over 18,000,000 tons of sugar were made and used at the opening of the war, less than 16,000,000 tons annually were produced in the two years after the Armistice. Im-

provement in 1920–21 brought the total up to 16,700,000 tons. In the United States per capita consumption from 1919 to 1921 was at about the same rate as in 1914 and net imports were larger than in either 1913 or 1914. Evidently reduction in sugar consumption occurred elsewhere; in Europe, which produced less than before the war, in the United Kingdom where industrial depression affected all markets, and in other countries which reduced their purchases. Consumption expanded notably in 1921–22.

The British market from 1914 to 1921 was controlled by the Royal Commission on the Sugar Supply. This body imported the entire sugar requirements of the country, distributed to refiners and manufacturers and finally enforced rationing measures. The Commission closed its active operations in February, 1921, with a net loss of about £25,000,000, which was the cost to the public treasury of maintaining a non-speculative market during and after the war. From 1,000,000 to 1,900,000 tons of sugar are used annually for home consumption in the United Kingdom. Export trade is almost negligible.

A radical change took place from 1913 to 1920 in the sources of imports. In 1913 sugar from Europe formed 81 per cent. of the imports, Cuban cane 11 per cent. and other sugar 8 per cent. In 1920 only 1 per cent. of the total was beet sugar, the Cuban share increased to 38 per cent. and the balance was other cane sugar. Return to pre-war conditions was well under way in 1921, when European sources furnished 20 per cent. of the imports and Cuba the same percentage.

Table H shows imports into the United Kingdom by countries for 1913 and from 1919 to 1921.

TABLE H—IMPORTS OF SUGAR INTO THE UNITED KINGDOM FOR 1913 AND 1919 TO 1921

Country	1913	1919 (in gross tons)	1920	1921
Raw sugar				
Germany	472,026	...	12,929	...
Austria-Hungary	160,858	...	...	...
Other countries in Europe	49,846	1,137	2,458	13,957
Java	99	172,838	335,599	26,172
Cuba	224,227	587,252	516,487	256,798
British West Indies[1]	47,736	113,307	124,878	111,733
Peru	27,487	77,577	48,883	73,385
Mauritius	20,075	153,682	139,193	184,748
Brazil	5,133	6,971	12,439	79,964
Other countries not in Europe	39,228	29,559	58,678	64,413
Total	1,046,715	1,142,323	1,251,544	811,170
Refined sugar[2]				
Germany	465,453	253	126	1
Austria-Hungary	198,064	990	102	138
Netherlands	178,567	20,643	1,066	91,032
Belgium	49,764	5,532	2,068	42,979
France	26,572	33	294	3,058
Other countries in Europe	3,448	712	103	107,371
United States	385	222,083	102,273	171,816
Java	...	117,060	5,014	4,340
Other countries not in Europe	292	94,828	8,766	47,609
Total	922,545	462,134	119,812	468,344
Grand total	1,969,260	1,604,457	1,371,356	1,279,514

[1]Including British Guiana and British Honduras.
[2]Including sugar candy.

THE UNITED STATES MARKET

Annual consumption of sugar in the United States amounts to about 4,000,000 tons, which provides nearly 85 pounds per capita. Sources of supply may be roughly divided as follows: Cuba furnishes about one-half, the domestic beet and cane production together about one-fourth, and insular possessions the remaining fourth. Any large increases which may occur in domestic production and that of Porto Rico, Hawaii and the Philippines are

likely to narrow the market for Cuban sugar in this country, although the Cuban product costs less to produce than American cane or beet. Total sugar consumption in continental United States and distribution according to sources of supply for the years 1913, 1919, 1920 and 1921 are shown in Table I.

TABLE I—CONSUMPTION OF SUGAR IN THE UNITED STATES AND SOURCES OF SUPPLY

	1913	1919	1920	1921
		(in gross tons)		
Total consumption	3,743,139	4,067,671	4,084,672	4,107,328
Sources of supply:				
Louisiana and Texas (cane)	207,708	154,034	81,625	272,773
United States (beet)	625,314	872,253	454,446	946,977
U. S. insular possessions (cane)				
Hawaii[1]	506,555	514,824	390,552	482,322
Virgin Islands	...	8,286	10,490	5,170
Porto Rico	331,103	286,880	334,936	373,762
Philippine Islands	44,620	72,511	114,048	131,168
Miscellaneous[2]	19,450	24,094	17,095	2,274
Cuba (cane)	1,990,831	2,077,051	2,127,461	1,866,153
Foreign countries (cane and beet)	17,558	57,738	554,019	26,729
Total, raw and refined	3,743,139	4,067,671	4,084,672	4,107,328
Consumption of refined sugar	3,678,144	3,899,944	3,474,770	3,895,026

[1]Including a small quantity of refined sugar.
[2]Maple sugar, etc.

To a greater extent than any other country, the United States reëxports imported sugar which has passed through domestic refineries. Practically no raw sugar enters into American exports. Europe's increased demands during the war caused great expansion in American exports, which rose from an average of 32,000 tons in the fiscal years 1910–14 to 700,000 tons in 1916. For the calendar year 1921 about 400,000 tons of refined sugar were ex-

ported. Since early in the war the United Kingdom and France have taken over half the exports, the remainder being widely distributed.

Government operation figured prominently in the sugar market, both local and international, during and after

TABLE J—PRICES OF RAW AND REFINED SUGAR IN THE UNITED STATES

Average for the year	Raw 96 degree centrifugal duty pd. N. Y. (cents per pound)	Refined f.o.b. New York
1900	4.60	5.30
1901	4.00	5.10
1902	3.50	4.50
1903	3.70	4.60
1904	4.00	4.80
1905	4.30	5.30
1906	3.70	4.50
1907	3.80	4.70
1908	4.10	4.90
1909	4.00	4.80
1910	4.20	5.00
1911	4.50	5.30
1912	4.20	5.10
1913	3.50	4.30
1914	3.80	4.70
1915	4.70	5.60
1916	5.80	6.90
1917	6.30	7.70
1918	6.40	7.80
1919	7.50	8.90
Price on 15th of month or nearest available date.		
1920		
January	13.04	[1]
February	12.04	[1]
March	11.54	[1]
April	18.56	[1]
May	21.57	[1]
June	19.56	[1]
July	18.31	[1]
August	13.04	17.10
September	10.78	14.75
October	8.03	11.00
November	6.51	10.00
December	4.63	8.25

	Raw	Refined[1]
1921		
January	5.52	7.75
February	5.77	7.25
March	6.02	8.00
April	5.64	7.65
May	4.89	6.50
June	4.00	5.75
July	4.37½	5.20
August	4.75	6.00
September	4.00	5.60
October	4.11	5.30
November	4.11	5.20
December	3.67	5.20
1922		
January	3.61	4.80
February	3.67	5.00
March	3.92	5.30
April	3.86	5.25
May	4.04	5.30
June	4.48	5.80

[1]No open market for refined sugar from January to August 11. Refiners allocated sugar to regular customers at non-competitive prices.

the war. In 1917 the United States Food Administration supervised American imports of raw sugar, prices and distribution. An international sugar committee was established later in the same year to procure supplies for the Allies as well as the United States. That body negotiated the purchase of the Cuban crop of 1917–18 from a Cuban commission.

The United States Sugar Equalization Board, created by the President in 1918, with the Royal Commission on the Sugar Supply purchased the Cuban crop of 1918–19. Regulation of domestic trade was relaxed in 1919 and purchases for England, France and Italy were made by the Allied Provisions Export Committee. Reference has already been made to the operations of the Royal Commission on the Sugar Supply. The purchase of the Cuban crop of 1919–20 was not authorized by the President of the

United States, and the Equalization Board passed out of existence early in 1920. The marketing of the Cuban crop of 1920–21 was placed in the hands of the Cuban Sugar Finance Committee which was established by decree of the President of Cuba in order to "sell the sugar production in an orderly manner and . . . so as not to permit the establishment of an artificial price." The Committee exercised its powers until the close of 1921, but its efforts to market the crop were only partly successful, as at the beginning of 1922 stocks of more than 1,000,000 tons of sugar remained in Cuba.

With increased consumption after the Armistice there developed in 1919 a general belief in the existence of a serious shortage and the removal of government control was followed by excessive speculation. As the price rose, imports were attracted from all quarters of the globe. The year 1920 was the period of most marked fluctuations in sugar prices ever recorded in the United States. The spectacular fall from a maximum of 23.57 cents a pound duty paid, for raws (May 19, 1920) to 4.63 cents (December 14, 1920) will long be remembered in the trade. Heavy stocks of sugar were carried into 1921, prolonging the period of price declines, and it was not until 1922 that recovery began. Yearly average prices of raw and refined sugar from 1900 to 1919 and quotations on the fifteenth of each month or the nearest available date from January, 1920, to June, 1922, are shown in Table J.

NOTE: Tables A, B, C, I and J are based upon statistical material from Willett and Gray's Weekly Statistical Sugar Trade Journal.

WHEAT

WHEAT is the main bread grain of all of Europe, North and South America and Australia, and of the white population of Africa, and is important as a food even in the rice-eating nations of the Orient, where its use appears to be increasing. It is successfully grown from the Tropics to the Arctic Circle and occupies nearly half as much area as all other reported cereal crops combined. In the years immediately preceding 1914 slightly over 260,000,000 acres were sown to wheat, and total world production averaged more than 3,500,000,000 bushels. The requirements of those countries whose domestic crops were insufficient for their needs were supplied chiefly from the surplus of Russia and the Balkan region of Europe, the United States and Canada, Argentina, Australia and India. The net movement from the exporting countries averaged 584,000,000 bushels, or about one-sixth of the total world crop.

Before the war, the Russian Empire led the world both in acreage planted to wheat and in total production. The main wheat belt is in the southern and southeastern parts of European Russia, which are particularly well adapted in climate and soil, and are convenient for water transport. About one-fifth of the total Russian crop was exported before the war, being shipped primarily through Black Sea ports. Wheat has been the chief cash crop of the Russian peasant. Potential production of wheat in

Russia is very great. The average yield is only ten bushels to the acre, due to unintelligent methods of farming as well as to erratic rainfall. Less than one-fifth of the total Russian crop prior to the war was produced in Asiatic Russia, which is probably the greatest undeveloped wheat area of the world.

The United States ranks next to Russia as a wheat producer, nearly one-fifth of the world crop having been grown here prior to the war. Wheat can be raised in practically all sections of the country, but the surplus which feeds the United States and plays a considerable part in making up the deficiency of the European supply comes from the great plains region west of the Mississippi River. In 1920 Kansas alone produced more than one-sixth of the total outturn of the country, and the seven plains states of Kansas, Nebraska, North Dakota, South Dakota, Minnesota, Oklahoma and Missouri produced over half of the total crop. The proportion of the crop exported has varied considerably, averaging immediately prior to the war less than one-sixth. From August 1, 1920, to July 31, 1921, exports amounted to nearly half the 1920 crop, a situation made possible by the large carry-over from the previous harvest. The best wheat areas of this country are now under cultivation, and in the normal course of events, as the United States becomes more and more an industrial country and population grows, wheat exports will tend to decline.

India is third among wheat-producing countries. The main part of the crop is grown in the northwestern provinces, and nearly half the crop of the Punjab is grown under irrigation. Wheat is a supplementary cereal crop in India, and there is wide variation in the home demand,

depending not only upon general prosperity, but upon the crops of rice and grain sorghums. Indian exports do not average more than one-sixth of the total crop, and the salability of the grain is somewhat impaired by lack of grading and by the inclusion of dirt from the threshing floor.

The great importance of Europe as a wheat producer is commonly overlooked because of heavy European grain imports, which are due not to failure to recognize the importance of wheat growing or to lack of a suitable climate or soil, but to the existence of a dense population which has maintained itself by manufacturing, and has, therefore, become dependent in large part upon an imported food supply. Before the war, Europe, including Russia, produced half of the entire wheat crop of the world, and exclusive of Russia, the European crop was one-third of the world crop. The French crop alone from 1908 to 1912 was nearly half as large as the wheat crop of the United States, although the area of France is only four-fifths of the area of Texas.

Canada, Australia and Argentina are all factors of great importance in supplying the international market. Canadian prosperity is to a large degree dependent on the wheat crop, since the value of this crop is equal to approximately one-third of the value of all farm crops. The plains region, extending northward from the great wheat-growing section of the United States, is the chief producing area of the Dominion. The large estates of Argentina and the shifting and irresponsible character of farm labor are a serious obstacle to the development of improved farming methods, while the scarcity of foreign capital during and since the war has militated against the extension of trans-

portation facilities and the opening up of new land. Thus there has been, of late, little tendency toward increasing the Argentine crop except as the chance result of favorable seasons. In Australia, two-thirds of the cultivated land is now in wheat. In each of these countries a small population accounts for the large exportable surplus.

The consumption of wheat cannot be ascertained with any degree of exactness, because not only are crop figures estimates at best, but it is also impossible to secure complete information as to carry-over from one harvest to the next of grain in farmers' hands or of flour in consumers' hands. The problem of estimating consumption in exporting countries is distinctly different from that in importing countries. In the latter group, under ordinary circumstances, with no inducement to accumulate an abnormally large surplus and no situation resulting in a depletion of reserves, the carry-over may be reckoned at substantially the same figure at the end of a given harvest year as at the beginning. In such a situation net imports added to production give an approximation of the amount of wheat required for seeding and for human consumption, together with the quantity used for feed. On this basis the apparent consumption of wheat in the chief importing countries prior to and since the war is presented in Table A, which shows also production and net imports for those years. It may be assumed that these countries, particularly the European ones, had but small reserves at the close of the harvest year ending July 31, 1918, nor does a normal reserve appear to have been accumulated up to August 1, 1922.

Western Europe is the chief area of wheat deficiency. The United Kingdom alone took prior to the war almost

half the total imports of the countries enumerated, while Germany took nearly one-seventh, Italy and Belgium each about one-tenth and France one-fifteenth. Since 1918 the total production of the designated importing countries has been less than the pre-war average, and the quantity of wheat apparently available for consumption has likewise been less, although net imports in 1919–20 and 1920–21 were higher than before the war. In 1921, however, all the countries enumerated except Belgium and Germany estimated outturns greater than before the war, and the total estimated production was 25,000,000 bushels above the pre-war level. The population of Europe has increased relatively little since 1914.

Wheat is consumed chiefly in the form of flour, and as indicated, the figures of trade in and apparent consumption of wheat in the above table and in that following include flour reduced to wheat equivalent. In most European countries a large part of the wheat required is imported in the form of grain and milled within the country. In fact, prior to the war Austria-Hungary, Belgium, France, Germany, Italy and Spain, though importers of wheat, were customarily exporters of flour to varying degrees, supplying principally neighboring countries of deficiency or their own outlying colonies. The greater part of Africa, western Asia, some of the South American countries, the West Indies and the islands of the Pacific, where milling is little developed, receive their wheat supplies chiefly in the form of flour.

Russia was, prior to the war, the chief wheat-exporting country of the world, furnishing to the international market an average of more than 150,000,000 bushels per year. The difficulties of transport during the war and the un-

TABLE A—PRODUCTION, NET IMPORTS AND APPARENT CONSUMPTION OF WHEAT, COUNTRIES, FIVE-YEAR PRE-WAR

	1908–09 to 1912–13 (5-yr. average)			1918–19		
	Production[1]	Net imports[2]	Apparent consumption[2] (in thousands of bushels)	Production[1]	Net imports[2]	Apparent consumption[2]
Belgium	14,618	49,526	64,144	4,919	[3]	[3]
Denmark	4,868	5,827	10,695	6,330	[6]266	6,064
France	317,070	32,794	349,864	225,715	71,456	297,170
Germany	145,578	66,992	212,570	93,274	[3]	[3]
Italy	171,114	53,027	224,141	183,277	92,614	275,891
Netherlands	4,887	20,427	25,314	5,274	11,812	17,086
Norway	307	3,347	3,654	1,087	6,804	7,891
Spain	131,948	3,784	135,732	135,697	11,452	147,149
Sweden	7,612	7,091	14,703	8,887	4,733	13,620
Switzerland	3,303	[8]16,202	[8]19,505	5,232	[6]6,443	[8]11,675
United Kingdom	59,081	211,971	271,052	96,078	171,631	267,709
Japan	23,500	2,902	26,402	31,013	6,815	37,828
Egypt	[9]33,205	7,421	40,626	32,137	980	33,117
Tunis	5,327	926	6,253	11,941	[5]3,574	8,367
Union of South Africa	[9]5,454	5,930	11,384	8,337	1,467	9,804
Total of countries enumerated[11]	927,872	488,167	1,416,039	849,198	382,366	1,133,371

[1]Harvests of 1908–12, 1918, 1919, 1920 and 1921, for countries in the Northern Hemisphere; 1908–09 to 1912–13, 1918–19, 1919–20, 1920–21 and 1921–22, for countries in the Southern Hemisphere.

[2]European harvest years, August 1 to the following July 31, for countries in the Northern Hemisphere; calendar years 1909–13, 1919, 1920 and 1921 for countries in the Southern Hemisphere. Includes flour reduced to wheat equivalent on the basis of a 75 per cent. milling ratio.

[3]Not available.

[4]Net imports are for the period July 1, 1920, to June 30, 1921.

INCLUDING FLOUR REDUCED TO WHEAT EQUIVALENT, IN THE CHIEF IMPORTING
AVERAGE AND 1918–19 TO 1921–22

	1919–20			1920–21		1921–22
Production[1]	Net imports[2]	Apparent consumption[3]	Production[1]	Net imports[2]	Apparent consumption[3]	Production[1]
		(in thousands of bushels)				
10,564	29,533	40,097	10,274	[4]32,168	[4]42,442	14,494
5,922	1,526	7,448	7,389	334	7,723	11,206
187,074	87,144	274,218	236,908	67,626	304,534	322,738
79,694	[6]12,000	91,694	82,575	[7]34,583	[7]117,158	107,789
169,753	79,317	249,070	141,324	98,020	239,344	192,819
5,694	18,630	24,324	5,765	18,717	24,482	8,685
1,071	6,349	7,420	999	3,786	4,785	972
129,238	17,139	146,377	138,592	19,778	158,370	145,137
9,508	7,373	16,881	10,527	6,535	17,062	12,576
3,523	[8]12,146	[8]15,669	3,586	[8]13,781	[8]17,367	3,799
71,504	210,551	282,055	56,834	198,108	254,942	73,800
30,673	12,685	43,358	28,406	5,737	34,143	26,918
30,134	8,714	38,848	31,707	8,976	40,683	37,007
6,981	[5]864	6,117	5,228	[10]1,002	[10]6,230	10,622
5,129	6,825	11,954	8,112	1,443	9,555	8,688
746,462	509,068	1,255,530	768,226	510,594	1,278,820	977,250

[5]Net exports.
[6]Estimated; net imports from January 1, to July 31, 1920, amounted to 7,680,000 bushels.
[7]Exclusive of net imports during the first four months of 1921, for which data are not available.
[8]Exclusive of net imports of flour for which data are not available.
[9]Four-year average.
[10]Net imports are for the period from September 1, 1920, to August 31, 1921.
[11]Exclusive of those for which data are not available, as noted.

settled conditions within the country since that time have eliminated Russia as an exporting country and have culminated in the present food shortage there, following the failure of the 1921 crop. The deficiency in the international supply as a result of Russia's withdrawal has, however, been made up by increased production in other countries.

The brunt of supplying the deficiency was borne by the United States and Canada, not only because of their facilities for increasing production but also because of the short haul in shipping to Europe. From a pre-war production of 666,877,000 bushels the yield in the United States climbed to the record crop of 1,025,801,000 bushels in 1915, and the average production for the war years was 805,053,000 bushels. Canada likewise increased its outturn to an average during the war of nearly 270,000,000 bushels, as compared with a pre-war average of 173,247,000 bushels. Argentina and Australia increased production also. The former averaged during the war years, with the exception of 1916–17 when the yield was very poor, 186,505,000 bushels and the latter averaged 130,464,000 bushels, as compared with a pre-war outturn of 157,344,000 bushels and 82,340,000 respectively. The difficulty of releasing ships for the long haul required to transport the wheat to Europe, however, made it hard to use these supplies, and the close of the war found large accumulations of grain in both countries. This grain was later worked off in increased exports to Europe, and at the close of the 1920–21 harvest year reserves in all exporting countries had been reduced close to the normal carry-over.

The average production, net exports and quantity of

wheat available for consumption in the chief exporting countries prior to 1914 are shown in Table B, together with similar figures for the period since the close of the war. It must be remembered, however, that the quantity available for consumption includes carry-over, and in several of the exporting countries the figures give evidence of the backing up of supplies.

Total production in the countries enumerated, exclusive of Russia, has not since the war reached the earlier level when that country was included, but because of the accumulation of grain in the Southern Hemisphere and the fortune of favorable crops net exports have been above the pre-war figure. The requirements of the 1921–22 harvest year have been met entirely from current production, thus demonstrating that even without Russia the world's present bread needs can be met so long as harvests are reasonably good. Supply and demand are nicely balanced, however, and a serious crop failure probably would cause a world shortage of wheat.

The flexibility of the wheat crop in meeting unusual conditions is well shown by the adjustments of the war years, but in general, allowance must be made for a certain lag in the response to altered circumstances. Almost a year intervenes before an increased or a decreased planting can affect world supply. The relative inelasticity of demand for wheat causes a quick reflection in price of any maladjustment between supply and demand. While other factors, such as inflation, must also be taken into account in following the course of the American wheat price since 1914, a fear of shortage in the main consuming centers, partly justified and partly the result of the speculative spirit of the time, was an underlying factor in the

TABLE B—PRODUCTION, NET EXPORTS AND APPARENT CONSUMPTION OF EXPORTING COUNTRIES, FIVE-YEAR PRE-WAR

	1908–09 to 1912–13 (5-yr. average)				1918–19	
	Production[1]	Net exports[2]	Apparent consumption[3]	Estimated carry-over above normal at beginning of harvest year 1918–19 (in thousands of bushels)	Production[1]	Net exports[2]
Northern Hemisphere—						
Austria, Hungary and the Balkan States ...	364,543	55,566	308,977	[3]	[4]63,878	[3]
Russia (in Europe and Asia, excl. Finland)...	734,942	150,880	584,062	[3]	[3]	[3]
Algeria................	33,573	4,795	28,778	[3]	49,232	8,873
India..................	323,899	48,317	275,582	[3]	370,384	13,585
Canada................	173,247	79,149	94,098	..	189,075	95,849
United States.........	666,877	96,740	570,137	[6]67,000	921,438	276,868
Southern Hemisphere—						
Argentina.............	157,344	94,918	62,426	90,000	171,586	123,874
Chile..................	22,378	2,417	19,961	[3]	20,278	2,509
Uruguay..............	7,196	1,389	5,807	[3]	6,890	1,373
Australia.............	82,340	49,415	32,925	158,000	78,021	109,999
Total of countries enumerated[11]........	2,566,339	583,586	1,982,753	181,000	1,870,782	632,930

[1]Harvests of 1908–12, 1918, 1919, 1920, 1921 for countries in the Northern Hemisphere; 1908–09 to 1912–13, 1918–19, 1919–20, 1920–21, 1921–22 for countries in the Southern Hemisphere.

[2]European harvest years, August 1 to the following July 31, for countries in the Northern Hemisphere; calendar years 1909–13, 1919, 1920, 1921 for countries in the Southern Hemisphere. Includes flour reduced to wheat equivalent on the basis of a 75 per cent. milling ratio.

[3]Not available.

[4]Exclusive of Hungary and Jugoslavia, for which data are not available.

[5]Exclusive of Hungary, Transylvania, Slovakia and Sub-Carpathian Russia, for which data are not available.

WHEAT, INCLUDING FLOUR REDUCED TO WHEAT EQUIVALENT, IN THE CHIEF
AVERAGE, AND 1918–19 TO 1921–22

	1919–20			1920–21			1921–22
Apparent consumption[2]	Production[1]	Net exports[2]	Apparent consumption[2]	Production[1]	Net exports[2]	Apparent consumption[2]	Production[1]
(in thousands of bushels)							
[3]	[5]167,234	[3]	[3]	204,382 [6]	[7]25,608	[8]229,990	260,316
[3]	[3]	[3]	[3]	[3]	[3]	[3]	[3]
40,359	14,484	1,932	12,552	6,797	[7]5,578	12,375	33,760
356,799	280,233	2,070	278,163	377,850	15,052	362,798	250,444
93,226	193,260	91,358	101,902	263,189	165,784	97,405	300,858
577,570	934,265	232,487	701,778	787,128	302,948	484,180	794,893
137,712	214,121	[9]198,603	15,518	169,739	[9]62,317	107,422	154,859
17,769	19,918	1,305	18,613	25,177	2,030	23,147	23,658
5,517	5,948	59	5,889	7,768	367	7,401	12,124
126,022	47,423	61,908	[10]	150,469	115,538	34,931	136,449
1,354,974	1,876,886	589,722	[12]1,134,415	1,992,499	632,850	1,359,649	1,967,361

[6]Exclusive of net exports from Bulgaria from March 1 to July 31, 1921.

[7]Net imports.

[8]Short of average carry-over.

[9]Gross exports.

[10]With carry-over from previous year of about 75,000,000 bushels, there were left for seeding and consumption about 60,515,000 bushels.

[11]Exclusive of those for which data are not available, as noted.

[12]Exclusive of Australia.

movement of prices during that period. Table C shows prices of representative grades of wheat on the fifteenth of each month, or nearest available date, from 1913 through 1921.

The factors entering into demand are much more complicated than are those which determine exportable surplus, and the supply of other cereals and breadstuffs must also be taken into consideration. Rye is extensively used as a bread grain in most north European countries, and to a less extent elsewhere. A number of wheat-importing countries are important producers of rye. In such countries, in times of dearth or when wheat is unduly expensive, it is always possible to consume more rye as a bread grain, if it is available, and thus to reduce wheat importations. It is significant that before the war, net exports of rye from Germany amounted to more than one-third of the net imports of wheat. While it is true that a large part of the rye crop is customarily used to feed animals, and measured in terms of net exports only a little more than one-twentieth of the total, or 80,000,000 bushels, entered into international trade before the war, nevertheless, conditions affecting the supply of and demand for rye are always of great importance in correctly appraising the wheat situation.

World production of rye is almost half that of wheat. In Table D is shown rye production by countries in the pre-war years, and 1918, 1919, 1920 and 1921, so far as data are available. It will be noted that rye is raised principally in the north European countries. It will grow in a less fertile soil and in a more severe climate than wheat. Efforts to increase the rye crop in Canada have not been without effect, production in 1921 being eleven

TABLE C—PRICE OF WHEAT AT CHICAGO ON THE FIFTEENTH OF EACH MONTH FROM 1913 TO 1920

Month	1913	1914	1915	1916	1917	1918	1919	1920	1921
				(in dollars per bushel)					
				NO. 1 NORTHERN SPRING					
January	.91	.91¼	1.43	1.25	1.92	2.20	2.26	3.10	1.84⅜
February	.91	.95	1.60	1.33	1.77¼	2.20	2.26¼	2.55	1.77
March	.87⅜	.95¼	1.60	1.16⅜	1.88	2.20	2.45	2.60	1.56¼
April	.91	.96	1.61	1.20⅞	2.40	2.20	2.44	2.95	1.33⅞
May	.91	.98	1.52	1.22	[1]	2.20	2.46	3.30	1.52
June	.94	.96	1.24½	[1]	2.86	2.20	2.33	2.95	1.52
July	.89⅞	.89	1.42	1.12⅝	2.38	[1]	2.43	2.95	1.40⅝
August	.91⅝	1.12	[1]	1.46⅝	2.30	2.26	2.42	2.66	1.34⅝
September	.92¾	1.14½	1.07½	1.57	2.20	2.27	2.35	2.46	1.33¾
October	.87	1.12	1.11	1.67	2.20	2.26¼	2.65	2.22½	1.23⅝
November	.89½	1.15	1.05½	1.81	2.20	2.27	[2]3 00	1.88⅝	1.19
December	.91⅞	1.20	1.16½	1.61	2.20	2.28	3.25	1.61⅞	1.17
				NO. 2 RED WINTER					
January	1.11½	.96¼	1.41⅞	1.28½	1.92	2.17	2.41	2.65	1.98
February	1.05	.95⅝	1.53	1.26½	1.77	2.17	2.30	2.40	2.01
March	1.02	.94⅝	1.58	1.13¼	1.86½	2.17	[2]2.35	2.47	1.65⅞
April	1.04	.94⅝	1.60	1.19	2.62½	2.17	[2]2.57	2.75	1.24⅞
May	1.04½	.96⅝	1.50⅞	1.18¼	3.10	2.17	[3]3.00	3.06	1.54⅝
June	1.03	.90⅝	1.11⅞	1.03¾	2.77	2.17	[1]	2.95	1.40
July	.84⅝	.78⅝	1.22⅝	1.15	2.15	2.25	2.23	2.85	1.31½
August	.86¾	.90¼	1.03½	1.39⅞	2.24	2.23	2.23½	2.56	1.25⅝
September	.91	1.01	1.13	1.49⅝	2.17	2.24½	2.23½	2.49	1.27⅞
October	.90¼	1.09	1.19	1.57½	2.17	2.24	2.24	2.39	1.22⅞
November	.94	1.13½	1.14⅞	1.83½	2.17	2.24	2.29½	2.11⅞	1.15
December	.95⅞	1.17⅞	1.21½	[2]1.80⅞	2.17	2.30½	2.45	2.00	1.14

[1]No quotation.
[2]Nominal.
[3]Quotation for seventh of the month.

times the pre-war average, and nearly double the outturn in any other year since that time. The 1921 crop of the principal producing countries for which comparable data are available was about 40 per cent. greater than that of 1920.

Barley is also used for human food, alone or in combination with wheat, in a number of countries. Moreover, the milling equivalent of wheat, which before the war was roughly estimated to be about 75 per cent., can be raised, and potato flour, corn flour and rice flour can be combined with wheat flour in the making of bread. Not the least important consideration in reckoning the supply of food-

TABLE D—RYE PRODUCTION IN PRINCIPAL COUNTRIES

	1908–12 (5-yr. aver.)	1918	1919	1920	1921
	(in thousands of bushels)				
Austria, Hungary and the Balkan States	175,672	[1]54,314	[1]57,958	85,148	112,116
Belgium	22,795	5,446	14,505	18,169	21,274
Denmark	18,292	12,727	14,909	13,242	12,205
Finland	[2]	8,639	10,506	9,173	10,386
France	49,354	28,936	30,579	34,494	44,496
Germany	433,549	316,483	240,174	194,266	267,662
Greece	[3]219	1,012	1,123	1,360	[4]3,152
Italy	[5]5,264	5,232	4,571	4,539	5,634
Luxemburg	622	387	368	338	488
Netherlands	15,973	12,954	14,290	14,246	16,646
Norway	952	1,012	983	970	1,043
Poland	[2]	[2]	103,049	73,663	167,224
Portugal	[2]	4,838	3,856	5,154	[2]
Russia (in Europe and Asia)	877,705	[2]	[2]	[2]	[2]
Spain	27,336	30,446	23,297	27,831	29,119
Sweden	24,734	19,293	23,074	23,056	27,813
Switzerland	1,665	1,850	1,575	1,622	1,800
United Kingdom	246	[6]242	[6]143	[6]136	[6]141
Canada	1,977	8,504	10,207	11,306	21,455
United States	33,011	91,041	75,843	60,490	57,918
Total of countries enumerated[7]	1,689,366	603,356	631,010	579,203	800,572

[1]Exclusive of Hungary, Jugoslavia, Transylvania, Slovakia, and Sub-Carpathian Russia, for which data are not available.

[2]Not available.

[3]1911 only; data for other years not available.

[4]Including maslin.

[5]Four-year average.

[6]Ireland only.

[7]Exclusive of those for which data are not available, as noted.

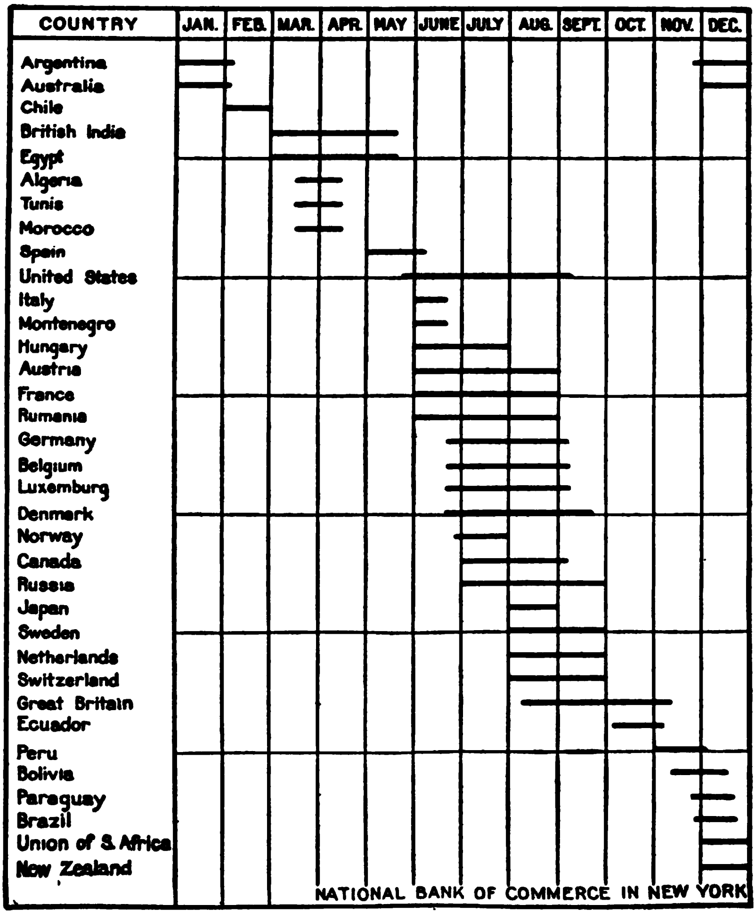
stuffs, particularly in the present situation in view of the impaired purchasing power of many European peoples, is the knowledge gained during the war of the use of substitutes not only for wheat flour but for bread itself, and the extension of the habit of using them. Thus, aside from the use of potatoes in the form of potato flour, they are a wheat substitute to an extent perhaps only to be measured by the supply in relation to the supply and price

of wheat, and the availability of other foods which can supply the food elements which potatoes lack. Corn-meal, widely used for food in the United States, is an accepted article of food in some parts of the Danube Basin which normally export wheat, and also in Italy. Large crops of corn and other coarse grains may indirectly lessen the demand for wheat by rendering available ample supplies of animal products at relatively low prices.

While in any one country the entire wheat crop, like that of other agricultural products, becomes available within a short time, the world supply is replenished at frequent intervals. Every month in the year finds wheat being harvested in some part of the globe, as is shown in the accompanying chart. This fact decreases the necessary cost of marketing wheat by lessening the time between harvesting and consumption during which the supply must be carried by some one. Moreover, climatic risks are scattered, so that both in time and quantity the danger of crop failure in one section has a reasonable chance of being offset by a particularly favorable outturn elsewhere. Production in the Northern Hemisphere is, generally speaking, fairly reliable, but the Southern Hemisphere crops and those of India are subject to greater climatic hazards, and the outturn shows marked variation despite relatively constant acreage. For example, the Australian crop of 1914–15 amounted to only 25,000,000 bushels, and the country became a net importer during the following season, although the area planted was somewhat larger than that of the previous year when over 100,000,000 bushels were produced.

Apart from the unprecedented conditions arising out of the World War, the population of the world is far from

WHEAT HARVESTING SEASONS IN DESIGNATED COUNTRIES[1]



[1]As compiled by the United States Department of Agriculture.

pressing against its wheat supply. Large areas suitable for growing wheat have not yet been developed, notably in Siberia and Canada. A potential source of increased production probably still more important in the aggregate is the possibility of more intensive use of the land already devoted to wheat. There is wide variation among countries in yield per acre, which is not altogether due to differences in climate and the fertility of the soil. The "black earth" of southern Russia is one of the most fertile of soils, yet the average yield of wheat per acre prior to the war was only ten bushels, whereas Germany and the United Kingdom each produced about thirty bushels to the acre. Table E shows average yields of wheat per acre in principal producing countries before the war, as reported to the International Institute of Agriculture. The highest average yield reported was forty-six bushels in Denmark. The selection and development of suitable high-yielding varieties of wheat frequently plays an important part in increasing production without extending acreage.

The factors which make a favorable environment for wheat raising are numerous and their relative importance is not definitely known. A warm, humid climate encourages the development of injurious diseases and therefore is not desirable, while at least nine inches of annual rainfall appear to be necessary unless irrigation is to be resorted to. Even more important than amount is the distribution of the rainfall, to provide moisture during the growing season and warm, dry harvest weather. Silt and loam of high fertility and with large humus content seem to be the most successful soils for wheat. As a consequence, most of the great wheat areas of the world are rolling plains, and in Italy alone are the fields not

sufficiently level for the use of machinery in planting and harvesting.

TABLE E—AVERAGE YIELD OF WHEAT PER ACRE, 1908–12 (1908–09 TO 1912–13 IN THE SOUTHERN HEMISPHERE) IN PRINCIPAL COUNTRIES

Country	Bushels per acre	Country	Bushels per acre
Austria	20.4	Switzerland	[2]31.1
Belgium	37.3	United Kingdom	31.8
Bulgaria	15.3	Canada	18.0
Denmark	46.1	United States	18.1
France	19.6	British India	11.6
Germany	30.8	Japan	20.2
Hungary	18.3	Algeria	9.5
Italy	14.4	Egypt	[2]25.6
Netherlands	35.5	Tunis	4.3
Norway	24.7	Union of South Africa	[1]8.2
Rumania	17.4	Argentina	10.0
Russia (in Europe)	10.0	Chile	20.1
Serbia	[1]15.6	Uruguay	[2]10.0
Spain	14.0	Australia	12.2
Sweden	28.5	New Zealand	30.5

[1]Three-year average.
[2]Four-year average.

In a moist climate grow what are known as soft wheats, while a dry and severe climate favors hard wheats. Russia appears to have been the original home of hard wheat. From there it was introduced into the plains region of North America where its suitableness for the climate is rapidly winning it first place in popularity. These sections constitute the two great hard wheat areas of the world. There is a difference in milling qualities of hard and soft wheats, but as American millers have become accustomed to handling the new varieties, hard wheats have tended to command a price equal to or somewhat higher than that of soft wheats, as they were accustomed to do in Russia.

Wheat is not at present raised extensively where the

growing season is less than ninety days in length. Severe winters, which are usually accompanied by a short growing season, make it impossible to raise fall-sown wheat, and extension of wheat raising into such areas depends upon the success of spring-sown varieties. The chief spring wheat areas of the world are in southern and eastern Russia, the northern part of the United States, and Canada, corresponding to the northern parts of the hard wheat areas. The development of hard spring wheat varieties has made it possible to extend into higher latitudes the area of wheat territory, and in Canada wheat has been grown at Fort Simpson, eight hundred miles north of Winnipeg, while in Alaska wheat has matured at Fairbanks, only two degrees from the Arctic Circle. The possibilities of still further expansion of the wheat area, and of the increase of yield through better farming methods and improved varieties, give promise of increasing production to meet the demand of a growing population.

Hand in hand with improved varieties of grain and better farming methods have been introduced economies in the handling of wheat and a more careful system of grading. No longer in the United States and Canada, for example, is any great proportion of wheat handled in bags. From the farms it goes to country elevators where it is stored in bulk. From there it is drawn loose into cars for shipment, to be unloaded into a terminal elevator for storage or into the hold of a ship for transport, or sent direct to the door of a flour mill. Loading and unloading are by gravity or suction and the wheat is transported from place to place by means of belt and spiral conveyors and other mechanical devices. Thus is eliminated the expense of bags and the cost of the additional manual

labor required for bagging and handling. In a modern flour mill, likewise, wheat passes through all stages from grain in the freight car to flour bagged for shipment without human intervention. Only here and there throughout the plant are men watching to see that nothing goes wrong with the machinery. The harbor of Sydney, Australia, has recently been equipped with a large terminal elevator and improved loading apparatus, and the first bulk shipment was made in the early part of 1921.

With bulk handling and elevator storage of grain goes a system of government inspection and certification in the United States and Canada which makes it possible to buy and sell wheat by grade, on terms which do not permit the purchaser to go back of the government certificate. This method has not been followed in other of the chief exporting countries. Russian grain is bought from a sample sent in ahead of the shipment. On Indian wheat allowance is made for more than an agreed percentage of dirt and Argentine wheat is sold on the basis of a guaranteed natural weight per bushel, with adjustment for divergence. In Australia a sample is made up by the authorities to represent the "Fair Average Quality" of the crop and this sample is used as a basis for sales.

The Great Lakes are an important American highway for transporting wheat, especially from the hard spring wheat area of northern United States and southern Canada. Thence export wheat is carried across New York by way of the Erie Canal or down the St. Lawrence River, or is shipped to the coast by train. Some wheat is sent down the Mississippi River, but at present the greater part of the crop for export moves eastward. Much of the Canadian crop is carried east by train but some of it passes out

through the Pacific ports to points in the Orient, or via the Panama Canal to Europe. The opening of the Canal has given considerable impetus to the use of the western outlet for the Canadian crop.

The importance of wheat in international economy can scarcely be overemphasized. Not only is it the principal cereal food for millions of people, but it is one of the world's chief ocean cargoes, affording before the war a tonnage nearly an eighth as great as that of coal and four times that of cotton. It flows from all quarters of the globe toward Europe and helps to balance demand for shipping by furnishing return loads for homeward-bound vessels. It is a large part of the currency in which the great agricultural regions pay for manufactured articles, both within and without national boundaries. Even before the war wheat and wheat flour were responsible for nearly a third of the total value of Canadian exports, and the proportion in Argentina was almost as great. In 1920 wheat represented a tenth of the value of exports from the United States. Thus the banker, the manufacturer, the trader have a stake in wheat, as do also the vast body of producers of wheat and consumers of bread, and it is not surprising that each year news of the crop is eagerly watched, and that the "Wheat Pit" of Chicago and the Corn Exchange of London are close to the center of business life.

WOOL

THE world's annual wool clip has not varied far from 3,000,000,000 pounds during the last ten years. Although in terms of weight this is only about one-fourth of the total annual cotton crop, it is a question even yet as to whether wool is not the most important raw material of the textile industry because of the great durability of the product and the need for wool fabrics in those colder areas of the world where modern civilization centers. The chief producing countries are those which have much pastoral land, the clips of Australia and Argentina together constituting about one-third of the total world supply. The highly industrialized countries of Europe and North America are the largest consumers, although wool in large amounts is used in the domestic industries of many less developed countries.

The international wool market is perhaps more complicated than is that for any other raw material. The sheep was domesticated in many different parts of the world before the beginning of history, and widely divergent types have resulted. Wool may be a major product, with mutton as a minor product, or sheep may be raised primarily for mutton, with wool reduced to the position of a by-product. Crossing of the many breeds of sheep with the object of securing maximum wool clip, or fine early lambs and superior mutton, or some combination of these qualities, has resulted in bringing into exist-

ence more than 200 types of sheep, each producing wool differing more or less from the others. The length and fineness of the fiber also differ on different parts of the body of the same animal.

Differences in quality are of the greatest importance from the standpoint of the wool manufacturer. As a result, more than 640 different grades of wool are recognized among American dealers, while for Australia alone a price list for 848 separate grades was at one time drawn up in order to value Australian wool. A journal well known in the textile industry of the United States regularly carries quotations on more than 75 different grades.

The remarkable range in quality in the raw material, and demand for specific grades in order to assure a desired quality in the fabric, have had pronounced effects on the character of the wool market, both in the wider, international sense, and in the local markets of the producing and consuming countries. The range of prices between the grades at the extremes of the scale is such that the markets for these wools may be regarded as almost independent of each other. Results of this complex situation are the absence of future trading and the development of varied and often indirect methods of marketing and financing wool from the producer to the manufacturer.

A further peculiarity of the international wool market which is in part the result of the double purpose for which sheep are raised, and which in part results from other conditions under which wool is produced, is the failure of supply and demand to adjust to each other promptly. Where sheep are raised primarily for mutton, wool continues to be produced as a by-product as long as there is a market for mutton and lambs. A large proportion of the

sheep raised primarily for wool are in areas of the world in which it is at present difficult to raise any other animals or crops with much hope of profit. It takes years to develop a good flock. Hence, flockmasters in these countries cannot at once lessen production in the face of a falling wool market. Even adverse weather, as destructive as it has been at times to flocks, especially those of Australia which have been repeatedly decimated by drouths, has not as a rule greatly affected the world's wool supply.

Sheep are raised in many countries. Hence, the wool supply as between different years is well equalized, and even shortage of special grades can be largely met in case of need by substitution. Variations in the price of wool over any ordinary period are, therefore, chiefly determined by conditions on the demand side of the equation, by artificial barriers to free international trade, such as tariffs and embargoes, and by changes in the general price level. The United States is both a producer and an importer of wool, home production being equivalent to only about one-half of consumption by American mills. The domestic clip of fine wools is quite inadequate for the needs of the wool manufacturers of the United States, and has been difficult of expansion. This condition, together with an uncertain tariff policy through many years, has contributed to the unstable and artificial character of the American wool market.

TECHNICAL CONSIDERATIONS

Consideration of certain practical aspects of the sheep industry, together with some technical questions concerning the wool fiber itself, in relation to spinning methods and product, are requisite for general understanding of

the international wool market. Wool differs from hair in essential characteristics. It has superior spinning qualities. Certain fine wools are superior to any other animal fiber in this respect. The scales or serrations on the wool fiber give wool fabrics felting and shrinking properties of great value. No other important textile raw material has these qualities in any comparable degree. Wool is highly elastic, and can be readily dyed in fast colors. Wool fabrics are comparatively impervious to cold and absorb moisture. As a result of the combination of these various qualities, they combine comfort, desirable appearance and durability to a degree which has as yet never been equaled by any substitute.

It is probable that sheep were valued both for food and for wool almost from the first stages of domestication. Until the development of refrigeration, by which fresh mutton and lamb can be conveyed great distances by rail and ship to consuming markets, sheep in frontier regions or other large areas of unoccupied land were usually produced primarily for wool, while those in thickly settled countries were raised primarily for food, wool being a secondary consideration. Refrigeration has so altered conditions that the price relation has become well-nigh the only determining factor as between wool and mutton.

From the standpoint of the sheep-raising industry, the sheep of the world fall into four broad classes. Least important of these groups are the so-called "native" sheep, the various unimproved breeds of many countries, all of which produce wool of grades below those used in the modern manufacture of clothing. Such wools are usually known as carpet wools. There are in Asia and southeastern Europe great numbers of such sheep, many

of them being of the fat-tailed varieties. The Karakul, a sheep of central Asia, also bearing wool of the carpet type, produces the furs known as Persian lamb, Astrakhan, and Broadtail. There are flocks of "native" sheep in Iceland, the fleeces of which have special value where a high luster is desired. The "native" sheep of other parts of the world have not infrequently served as the foundation on which modern flocks have been built, some of these breeds having qualities of special value. It is true in a general sense, however, that except as suppliers of carpet wool, all these "native" sheep have practically no importance from the standpoint of the international market, although they are of great value as sources of clothing materials and food for the semi-nomadic inhabitants of the countries where they are raised. The hair of the Angora goat, known commercially as mohair, and the hair of the alpaca, vicuna and camel have uses similar to those of wool, but they differ in essential qualities, are used only for special purposes, and the quantities produced are small.

The flocks of western Europe, North and South America, South Africa, Australia and New Zealand, which furnish the world's supply of wool suitable for the manufacture of fabrics for clothing, and of mutton and lamb for food, fall into three classes, the result of centuries of careful breeding and selection: those sheep bred primarily for wool, those in the production of which mutton is the prime object, and crossbreds, the result of various methods of crossing the two fundamental types.

The basis of all the flocks of the world which are maintained primarily for wool is the Spanish merino, the term "merino" and "wool type" having become almost synonymous. The merino was developed in Spain centuries

ago, and from it special types have been developed in several countries. As compared with the mutton breeds, merinos are small, hardy, slow-growing, long-lived, and suitable for handling under range conditions. Although some breeds of merinos are good mutton sheep, in general the type lacks the evenness of line, fullness of outline, tendency toward early maturity, and disposition to lay on external fat, which are the essential qualities where production of mutton and lamb is the primary object.

Types of merinos have been developed of which 20 per cent. of the weight of the live sheep is wool, and for which 30 pounds is not an uncommon weight in the grease for the fleece of a single ram. Merino wools now constitute between one-fourth and one-third of the world's supply. They are characterized by their softness and fineness, these qualities being combined with strength and elasticity. They are a necessity for the manufacture of the finest woolen and worsted yarns. The length of staple varies somewhat among the various merinos, but practically all are included in a range of from 1½ to 3 inches. Merino wools in the natural state are loaded with grease, some varieties scouring out as much as 75 per cent., the usual range being from 50 to 60 per cent. The main merino flocks of the world are those of Australia, the United States and South Africa, although a number of European countries produce important quantities of merino wool. In the past Uruguay produced considerable merino wool, but is becoming predominantly a crossbred wool country.

The ideal mutton sheep must have a deep, wide, symmetrical body, set on short legs. This conformation enables the butcher to cut the carcass to the best advantage, with little waste, and furnishes the highest percentage

of desirable cuts. Consumption of mutton is declining in relation to the consumption of lambs. From 70 to 80 per cent. of the sheep which now reach the market are less than a year old, and this tendency has made rapid growth of lambs a requisite. It is also important not to neglect the shearing qualities of mutton sheep, as the wool is a valuable product of any flock, but breeding skill has been definitely concentrated on the question of meat production.

There are many breeds of mutton sheep, but all of them, with the exception of the Tunis sheep, which is of little numerical importance, depend for their mutton qualities on the characteristics of the British breeds, of which 38 are recognized. These have always been bred primarily for mutton, quantity, quality and character of wool being only a secondary consideration. The British breeds originated from two general types, hence may be grouped into two main divisions. The long-wool breeds are characterized by great size, slow maturity and a tendency to coarseness of flesh, and by heavy yields of long wool, tending to coarseness. Wools of this type are known to manufacturers as luster or semi- or demi-luster wools. They are poor as to felting qualities and are used in the making of braids or of dress goods when luster is desired. Representative breeds of long-wool British sheep are the Lincoln, which grows a wool from 8 inches up to 15 inches in length, unwashed fleeces averaging from 14 to 18 pounds, and Cotswold, with fleeces ranging from 10 to 15 inches in length and weighing from 15 to 18 pounds. The long-wool breeds originated in low fertile lands, and are best fitted for such an environment.

The other group of British breeds, known as medium-

wool sheep, are generally smaller than the long-wool type, and were developed on rolling downs, hills and thinner soils. According to character of wool, they are divided into the "down" and the "mountain." The down breeds are noted for their fine mutton qualities, and they furnish the bulk of British medium wools. Down wools range in length from 1 to 5 inches. These wools are finer and softer than are those of the long-wool breeds, and they possess strength, elasticity and good felting properties. The down breeds are now popular in the chief mutton- and lamb-producing countries and are the leading type of England. The more important breeds are the Southdowns, with unwashed fleeces ranging from 5 to 8 pounds in weight; Shropshires, the fleeces of which range from 8 to 10 pounds in weight; Oxfords, with fleeces of from 10 to 12 pounds, and Hampshires, which yield on the average about 8 pounds of unwashed wool. Of the "mountain" breeds of mutton sheep, only the Cheviot is well known. Wools of this class are not important.

The development of crossbreeding between the various merinos and the mutton breeds by the application of modern principles has shown conclusively that it is possible to secure good wool, as well as superior mutton and lambs, from the same flock. As a result of this development, the world's clip of crossbred wools now exceeds the production of merino wool.

No domestic animal has proved more adaptable to varying conditions as to climate and food supply than the sheep, which can be raised successfully either on lush pasture or on what is practically a desert, at sea level or almost to the limit of vegetation on mountains. This adaptability has determined the three main methods by

which sheep are now raised: (1) under farm conditions, i. e., when land-holdings are fairly small and where sheep are raised in connection with general farming of various types; (2) the paddock system, in which sheep are allowed to run practically at will, within large fenced areas; and (3) on ranges. This latter method is adapted to the frontier, where there are large areas of unoccupied land. Under range conditions sheep can be handled in large flocks by herders. Where sheep are raised under farm conditions, mutton and lamb are usually the major product, and sheep of the distinctive mutton types prevail, although there are important exceptions. Wool is usually more important than mutton and lamb where sheep are raised on ranges or in paddocks, and merinos or merino crossbreds are preferred, both because of the quality of their wool and their excellent herding qualities.

As the frontier regions of the world are gradually settled, there is an inevitable tendency away from range methods, first toward the paddock system and then to farm conditions. It has been well demonstrated that except under very unusual circumstances, from the standpoint of profit, sheep raised under farm conditions for wool exclusively cannot compete with other farm animals and crops. Where there is a large consistent demand for superior mutton and lamb, sheep may be found very profitable in highly developed agricultural countries, as evidenced by the fact that in the United Kingdom, which has an area of 121,000 square miles, the number of sheep was officially estimated in 1921 as 24,000,000 with a clip of 100,000,000 pounds. American consumption of mutton and lamb, though increasing, is as yet limited, and in the same year, this country, with an area of 3,000,000 square

miles, had but 36,000,000 sheep, with an estimated clip of 273,000,000 pounds.

In practically all countries except those of western Europe, there are large areas which are unsuited by reason of climate or other conditions for the more intensive forms of agriculture, and in such regions sheep will continue to be raised profitably for wool as the major product. It is nevertheless true that, considering the world's sheep industry as a whole, the mutton types and crossbreds are gaining on the merinos. Thus, in New Zealand, pure merinos now constitute less than one-fifth of the pure-bred stock of the Islands, and only 4 per cent. of all sheep. Merinos have been practically displaced by crossbreds in Argentina, this process is under way in Uruguay, and fine wool sheep have long been of negligible importance in Europe, at least outside of Spain. In the United States the tendency is toward crossbreeding, except in a few localities. Although merino wool constitutes more than half of the total Australian clip, even there the merino appears to be losing ground. The only important wool-growing country where merinos are now the dominant type is the Union of South Africa, where, according to the latest information available, 72 per cent. of the total number of sheep are merinos.

Wool manufacturers of those countries in which the making of high-grade fabrics is important have viewed the drift away from merinos with great anxiety. At the same time, if the demand for fabrics of those classes for which merino wools are essential is sufficient to maintain a price differential between them and other grades which will make the production of merino wools profitable, there is no doubt that their production will be expanded to meet it.

MARKET TERMS

As wool reaches the market, it varies widely as to condition both as a result of the relative care or lack of care with which sheep and clip have been handled, and as a result of differing market customs. The wools of Australia and New Zealand are perhaps the superior of all others as regards care and skill in preparation for the market. Not only are they carefully sheared, but they are "skirted" by the removal of the poorer parts of the fleece.

As it comes from the sheep's back, wool contains much natural grease and some other foreign matter. In this condition, it is said to be "in the grease." The process of removal of this extraneous material is known as "scouring," and wool which has passed through the process is described as "scoured wool." Loss in weight during scouring is called "shrinkage," which varies from 20 to 80 per cent., the heaviest loss being as a rule in the fanciest merino wools. On a basis of shrinkage, say, of 50 per cent., 100 pounds of wool in the grease would yield only 50 pounds of clean wool. Shrinkage varies, not only between different breeds of sheep and between countries, but even in the same flock from year to year, so that comparisons as to quantities and as to prices, if on a grease basis, are only the roughest approximations of facts, although it is often necessary to use such data for lack of better.

The two main divisions of the wool manufacture are the woolen and worsted industries, in which two quite distinctive methods of manufacture are used. In the woolen system, the wool is carded, by which is meant that prior to spinning, the fibers, while separated to a certain extent,

are left crisscrossed, lying in no general order. In this condition, they are spun directly on the mule.

In the worsted industry, the fibers are first carded and then combed. Combing produces a continuous strand of long, parallel fibers known as "top" from which the inferior fibers, those which are short, weak or tangled, are separated, being known as "noil." "Top" is spun into worsted yarn. "Noil" is a raw material of the woolen industry. In the United Kingdom top-making is usually carried on by manufacturers who are not makers of yarns or cloth, but this is not so customary in the United States. "Tops" and "noils" are regularly quoted on many markets.

GRADES OF WOOL

The tariff schedule of the United States classifies wools as clothing or carding wools, combing wools, and carpet wools. In the trade, wools suitable for the manufacture of fabrics are separated into three main classes: clothing or carding wools, which are short wools suitable for woolen manufacture; French or baby combing wools of intermediate length, of which grades $\frac{1}{2}$ blood and above are suitable for manufacture on the French system, and grades $\frac{3}{8}$ and below ordinarily are used on the worsted system for knitting and weft yarns; and combing wools, suitable for manufacture on the worsted system for weaving and warp yarns.

Grade names are further complicated by the use of different systems of classification in various countries, and by variations in usage even in different parts of the same country. There are special classes of wools which fall outside the main systems of wool classification in use,

the largest group being carpet wools. As heretofore noted, they come mostly from the countries of Asia and southeastern Europe, being grown on "native sheep." They are coarse and otherwise inferior, and by no means all grades are suitable for the manufacture of high-grade carpets and rugs. There is no hard and fast line between carpet wools and other grades, however. When the prices of other wools are very high, the better carpet wools may be used to mix with them in the manufacture of blankets, coarse overcoatings, and similar fabrics. On the other hand, much carpet wool comes from the inferior parts of the fleeces of other than the so-called "native" sheep, while another source of supply is "pulled wool," that is, wool from the skins of slaughtered sheep. Carpet wools are usually designated in market quotations by country of origin, and various descriptive terms. They are usually graded as coarse, common, medium and good.

There are two systems of classification of those grades of wool used in the manufacture of worsted fabrics for clothing which may be said to be widely used: the Bradford system, and the American or "Boston" classification.

The Bradford or foreign topmakers' system for classifying wool assumes that wool is of the same quality as the finest count of yarn to which it can be commercially spun.

The yarn unit is a hank consisting of 560 yards. If this hank weighs one pound, the yarn is "one count." If it takes two hanks to weigh one pound, the yarn is "two count." Wool that at its highest spin would make "one count yarn" or "two count yarn" would be designated as "ones" and "twos" respectively, although as a matter of practice, yarns of such low counts are never made. If it takes 50 hanks of yarn to make a pound, the yarn

would be "fifties count yarn" and the wool that at its highest spin would make "fifties count yarn" would be designated as "fifties quality wool." Thus the finer the yarn which can be made from wool, the higher the "count" of the yarn and the higher the "quality" of the wool that is suitable for making this yarn.

As a matter of fact, these designations are only approximate. Climatic conditions vary the count of yarn that can be spun from wool of a given quality.

The Bradford system originated at Bradford, England, but is now used in Australia, New Zealand, and at least to some extent in South America, South Africa, and on the Continent.

The "Boston system" is chiefly in use in the United States, although a similar system is used in Canada, and a related terminology is also sometimes applied to South American wools. Originally the American wool market graded its wools on the so-called "blood classification," i. e., according to the proportion of merino blood in the sheep producing the fleece. Although the significance of this terminology has now been lost, such terms as "$\frac{3}{8}$ blood" referring not to proportion of merino blood but to the fineness of the wool, the terms themselves persist. Unfortunately, there are variations even in the terms applied to wools produced in different parts of the United States. Thus the wools of the eastern states, that is, those of the Ohio Valley, Michigan, New York, Wisconsin, Missouri, and New England, are designated as "domestic," while those of the Dakotas, Montana, Nevada, Utah, Colorado, Idaho, Wyoming, New Mexico, Arizona and eastern Oregon are known as "territory." There are special classes for Texas, California and western Oregon.

There are many other distinctions between grades than length and fineness of staple. Thus "pulled wool," that taken from the pelts of slaughtered sheep, differs in essential ways from the wool sheared from the living animal. The first fleece clipped from a sheep differs from later fleeces from the same animal, and is designated in the British market as hog, hogget, or teg wool. In localities such as Texas, where sheep are often sheared twice a year, the number of months' growth becomes a designation, while color, breed and an infinite variety of conditions may be embraced in grade terminology.

It is thus clear that any attempts to present parallel grades by the different systems can give only the most general idea of the relation between them. Nevertheless, Table A, showing equivalents of some of the leading grades, may be of value in an understanding of current market quotations. It must be clearly understood, however, that these grades are equivalent only in a general way, and especially that the counts spun in England from wools graded according to the Bradford system are higher than the counts spun from the corresponding grades in the United States.

TABLE A—EQUIVALENT GRADES OF WOOL AS CLASSIFIED ACCORDING TO THE BOSTON AND BRADFORD SYSTEMS

	BOSTON SYSTEM		BRADFORD SYSTEM	
Domestic	Territory	Pulled	Foreign	Counts spun in U. S.
Full blood (XX)....	Fine	AA	66s to 74s	60s and lower
¾ blood (X)........	Fine medium	AA	64s	50s " "
½ blood............	½ blood	A	60s	40s " "
⅜ blood....	⅜ blood	B	56s to 58s	36s " "
¼ blood............	¼ blood	B	50s to 56s	32s " "
Low ¼ blood........	Low ¼ blood	C	46s	20s " "
Common...........	Common	C	40s to 44s	16s " "
Braid..............	Braid	C	32s to 40s	16s " "

The United States Department of Agriculture is now endeavoring to assist wool growers in standardizing wool grades in this country. Especially is it desired to establish definite physical standards, thereby eliminating to a large extent differences in grading which result from differences in judgment as between graders. A standard working set has been prepared and has been actually used for the grading of wool in Missouri, Virginia, and Texas, as well as in a number of other states. Grades as at present established are to be regarded as tentative, and their adoption is purely voluntary, whether by state authorities, local wool marketing associations or dealers. It is believed that their use will widen. The government classification at present is as follows:

Fine clothing
Fine French combing
Fine strictly combing
½ blood clothing
½ blood French combing
½ blood strictly combing
⅜ blood clothing
⅜ blood baby combing
⅜ blood strictly combing
¼ blood clothing
¼ blood baby combing
¼ blood strictly combing
Low ¼ blood clothing
Low ¼ blood baby combing
Low ¼ blood strictly combing
Common
Braid
Burry, seedy and chaffy
Cotted
Dead and merrin
Kempy
Damaged
Black and gray
Pieces
Tags

DISTRIBUTION OF SHEEP IN THE WORLD

Exact data as to the number of sheep and the annual wool clip of the world are not available, even for those

countries in which agricultural statistics are most highly developed, while estimates in use as to both sheep and wool for many countries can hardly be called more than guesses. Moreover, production data and figures for exports and imports usually fail to distinguish between scoured wool and wool in the grease, so that all that can be done is to accept totals, regardless of the fact that they may contain widely varying proportions of scoured wool and of wool in a greasy condition. Satisfactory data for a number of countries, especially those of southeastern Europe, have not been available since the war, and changed boundary lines have further complicated the problem of comparability.

The best information, however, comes from the main consuming and producing countries, while most of those areas for which only the most uncertain data are available play little part in the international market, except for carpet wool. Such data as can be had are therefore of

TABLE B—NUMBER OF SHEEP IN THE WORLD, BY PRINCIPAL COUNTRIES, FOR THE LATEST AVAILABLE DATES

[Compiled from National Association of Wool Manufacturers Annual Review, 1921, and published data of United States Department of Agriculture]

Country	Year	Number of sheep (in thousands)
North America		
United States—continental	1921	[1]36,048
Canada	1921	3,676
Other countries	...	1,010
Total		*40,734*
South America		
Argentina	1921	37,000
Brazil	1921	12,000
Chile	1918	4,434
Uruguay	1916	11,473
Other countries	...	11,830
Total		*76,737*

Country	Year	Number of sheep (in thousands)
Europe		
Bulgaria	1921	8,500
Czechoslovakia	1921	976
Denmark, inc. Iceland and Faroe Islands	1920	[2]1,192
Finland	1920	800
France	1920	9,406
Germany	1920	6,139
Greece	1918	5,468
Hungary	1921	1,284
Italy	1921	12,000
Jugoslavia	1921	6,836
Norway	1918	1,208
Poland	1919	2,300
Roumania	1921	8,662
Russia in Europe	1916	[3]63,833
Spain	1921	20,522
Sweden	1919	1,564
United Kingdom	1921	24,161
Other countries	...	[4]11,149
Total		[4]*186,000*
Asia		
British India	1919–20	21,984
Russia in Asia	1915	34,468
Turkey in Asia	1912	27,095
China	1921	25,880
Other countries	...	5,512
Total		*114,939*
Africa		
Algeria	1914	9,140
Union of South Africa	1921	34,573
Other countries	...	26,287
Total		*70,000*
Oceania		
Australia and Tasmania	1920	72,767
New Zealand	1921	23,285
Total Australasia (approximately)		96,052
Other countries		10
Total		*96,062*
Grand total—World		584,472

[1]United States Census figure.
[2]Iceland and Faroe Islands year 1919.
[3]Goats included.
[4]No estimate for Turkey in Europe.

more value than might appear, in determining the situation as to the world's supply of, and demand for, wool for the manufacture of clothing.

It will be readily understood that because of diversity of breeds, the wool clip of a country is not necessarily commensurate with the number of sheep. Thus, the wool produced in the countries of southeastern Europe and of Asia is not only practically all of the carpet grades, but the quantity is small in relation to the estimated number of sheep, while the clip of such countries as Australia, New Zealand, and South Africa, where sheep-breeding is carried on with great skill, is heavy in relation to the reported number of animals.

Table B shows the estimated number of sheep in the more important countries, for the latest year for which data are available, as well as estimates by grand divisions and for the world as a whole.

The relatively large numbers of sheep reported in European and Asiatic Russia and Asiatic Turkey are chiefly significant as indicating the extent to which climate and vegetation of these areas favor the pastoral industries. Whenever the need for new sources of wool supplies becomes great enough, the wool clip of these countries can be tremendously increased, but such gains would mean the gradual encroachment of modern methods upon the semi-nomadic lives of the inhabitants.

THE WORLD'S WOOL SUPPLY

In 1921 the wool clips of Australia, New Zealand, Argentina, the United States, the Union of South Africa, Spain, Uruguay, and the United Kingdom amounted to nearly 2,000,000,000 pounds out of a total world clip of less than

3,000,000,000 pounds. The wool production of these eight countries constituted a much higher proportion of wools suitable for clothing. Average annual production for Australia and New Zealand together is about 800,000,000 pounds of wool. The entire product, with the exception of a certain proportion of waste from the inferior parts of fleeces, is suitable for the manufacture of clothing fabrics. The countries next in importance as wool producers are the United States and Argentina, each producing not far from 300,000,000 pounds per year. Almost the entire clip of Australia, New Zealand and Argentina passes into international trade, while exports of wool from the United States are negligible. The annual clip of the Union of South Africa varies considerably, but has probably averaged not far from 150,000,000 pounds during the last ten years. Practically the entire clip is available for export. Spanish wool production, which underwent remarkable expansion during the war, was about 142,000,000 pounds in 1920, and a large part of the clip was exported to neighboring European countries. In 1921 the Spanish clip was 165,000,000 pounds. Uruguay and the United Kingdom each produce about 100,000,000 pounds of wool annually. A large part of Uruguayan wool is merino, and practically all of it is exported. The wool grown in the United Kingdom is chiefly from mutton breeds and is used at home.

Table C shows wool production by countries. Figures are for 1921 for those countries for which data are available for that year. For some other countries production for 1920 is shown. In a few cases, only estimates are to be had.

Table C—World Production of Wool in 1921 by Countries[1]

Country	1921 (in thousands of pounds)
North America	
United States	273,064
British North America	24,050
Mexico	500
Other countries	750
Total	*298,364*
South America	
Argentina	300,000
Brazil	60,000
Chile	26,000
Peru	12,000
Falkland Islands	3,200
Uruguay	110,000
Other countries	5,861
Total	*517,061*
Europe	
Austria	1,840
Belgium	1,226
Bulgaria	17,637
Czechoslovakia	4,294
Denmark, Iceland and Faroe Islands	3,508
Finland	3,250
France	39,600
Germany	42,975
Greece	16,000
Hungary	11,023
Italy	58,000
Netherlands	5,500
Norway	4,409
Poland	6,724
Portugal	6,245
Roumania	38,192
Russia	150,000
Spain	165,347
Sweden	4,720
Switzerland	800
Turkey	[2]
United Kingdom	100,000
Jugoslavia	26,372
Total	*707,662*

Country	1921 (in thousands of pounds)
Asia	
British India	60,000
China	50,000
Persia	12,146
Russia in Asia	45,000
Turkey in Asia	90,000
Other countries	2,854
Total	*260,000*
Africa	
Algeria	33,184
British South Africa	120,000
Tunis	3,735
Other countries	12,505
Total	*169,424*
Oceania	
Australia and Tasmania	536,542
New Zealand	181,480
Australasia	718,022
Other countries	70
Total	*718,092*
Grand total	2,670,603

[1]Computed on a greasy basis.
[2]Not available.

WOOL CONSUMPTION

Since wool production is seasonal, and since distance and other factors mean that a considerable time must elapse between the clipping of the fleece from the sheep's back and the first stages of manufacture, stocks of wool in the international sense are heavy at all times, although they may vary considerably with the seasons, and widely as between different years. Over a series of years, however, it is obvious that the world's wool production and consumption must be in approximate balance. Normal, or average, world consumption since 1900 may therefore

be considered as about 3,000,000,000 pounds of wool a year.

From the standpoint of the wool market, a distinction must be made between those countries where woolens are woven by primitive methods for household use, largely in the homes of the people, and those countries which use large-scale factory methods. The wool consumption of such countries as British India, Asiatic Russia, Asiatic Turkey, and China is primarily for household industry. Rugs and carpets made from the native wools of these regions are important in international trade, and domestic consumption is at all times a factor in determining the amount of carpet wool which will be available for export, but such countries are not at present potential wool importers. Countries in which the wool textile industry is as yet little developed, and whose wool production is very large in relation to population, as Australia and Argentina, are chiefly factors on the supply side.

Demand in the international sense is determined primarily by conditions affecting the woolen and worsted industries of the United Kingdom, the other countries of northwestern Europe, including European Russia, and the United States. Stocks of wool in these countries are considerable at all times, but over a series of years commercial consumption of new wool may be measured by domestic production, plus imports, less exports. It is to be clearly understood that actual consumption by the inhabitants of a country may be quite different from commercial consumption. To determine actual consumption, account would have to be taken of the wool content of all exports and imports of wool manufactures, and this cannot be accurately done on the basis of existing statistics of foreign

trade. Throughout this discussion, the term "consumption" has reference only to consumption in the commercial sense.

The presence of tops and yarn in considerable quantity in the foreign trade of some countries is a complicating factor in any attempt to determine the amount of wool which is actually consumed in the manufacture of wool fabrics. Wool for top-making and wool spun into yarn is included in the apparent wool consumption of any country, as determined by domestic production plus net imports of raw wool. From the standpoint of cloth manufacture, wool consumption of a country which is a net importer of tops or yarn should be increased by the amount of raw wool required to make them, while from the standpoint of countries which are net exporters of tops or yarn, wool consumption for cloth manufacture should be correspondingly reduced. Existing data do not permit of the making of such corrections for foreign trade in tops and yarns, however.

The war so greatly disturbed conditions in many important wool-using countries that pre-war figures are perhaps a better indication of potential consumption than are data for the war years or since 1918. At the same time, it is to be remembered that in some important consuming countries there has been a sufficient increase in population to suggest permanently higher requirements. In others, some expansion in the capacity of wool-using industries occurred. On the other hand, there has been serious disorganization of the wool textile industry in many European countries, due to change of boundaries and unsettled political conditions, while shortage of raw wool, inability to buy it in pre-war quantities because of disadvantageous

exchange, and above all, the impoverishment of the ultimate consumers of fabrics made of wool, have tended to curtail manufacturing activities. There are no grounds to justify the conclusion that the pre-war status will return. With these reservations, Table D, showing estimated commercial consumption of wool in the thirteen chief wool-using countries from 1909 to 1913 may be of value.

These countries are supplied from an equally small group of countries. Table D also shows for the same prewar period net wool exports from the twelve countries which furnish most of the wool for the international market. Although transportation was greatly disturbed from 1914 to 1918, the war made no changes likely to prove permanent in conditions surrounding wool production in the exporting countries included in the table.

Prior to 1914, the United Kingdom, France, the United States, Germany, Russia, Austria-Hungary, and Belgium, in the order named, were the leading wool-consuming countries. Total average annual consumption for the group was about 2,700,000,000 pounds, as compared with an estimated average world production for the five years before the war of 2,900,000,000 pounds.

The war exerted widely varying effects on the woolen and worsted industries of these countries. The French industry fell almost entirely within the devastated area. Belgium was occupied and both Belgium and Germany were cut off from their customary sources of imported raw materials, as were also Austria-Hungary and Russia. During the latter part of the war, the British industry was handicapped by lack of labor, and restricted its prod-

TABLE D—COMMERCIAL CONSUMPTION OF WOOL BY PRINCIPAL CONSUMING COUNTRIES FROM 1909 TO 1913

Country	Production	1909–13 (5-yr. aver.) Net Imports	Net Exports	Available for consumption
		(in thousands of pounds)		
Exporting				
Algeria	35,221	...	17,554	17,667
Argentina	328,204	...	327,990	214
Australia and Tasmania	728,198	...	676,378	51,820
British India	53,631	...	32,775	20,856
Chile	17,430	...	[1]	[1]
China	50,000	...	42,684	7,316
New Zealand	192,147	...	190,231	1,916
Persia	10,023	...	8,056	1,967
Peru	9,333	...	9,155	178
Spain	52,000	...	26,059	25,941
Uruguay	139,178	...	139,178	...
Union of South Africa	164,651	...	164,651	...
Importing				
Austria-Hungary	41,600	63,942	...	105,542
Belgium	1,060	103,927	...	104,987
Canada	11,000	6,471	...	17,471
France	80,688	516,655	...	597,343
Germany	25,600	439,171	...	464,771
Japan	13	10,223	...	10,236
Netherlands	3,556	5,629	...	9,185
Norway	8,160	3,521	...	11,681
Russia	210,892	73,778	...	284,670
Sweden	6,060	7,118	...	13,178
Switzerland	1,049	10,873	...	11,922
United Kingdom	136,021	508,904	...	644,925
United States	313,648	203,289	...	516,937

[1]Not available for sheep's wool separately. Total exports including hair of the vicuna and mohair were 27,533,000 pounds.

uct primarily to those classes of fabrics required for military purposes. Wear and tear on machinery was great, and it is doubtful whether the physical productive capacity of the woolen and worsted manufacture of the United Kingdom more than held its own.

The war was a powerful stimulus to the industry of the United States. Imports of wool manufactures were in large measure cut off, and domestic prosperity resulted in

an active demand for fabrics. In addition, in 1915 and 1916, American mills were in receipt of large orders from some of the Entente countries for uniforms and other military supplies requiring wool fabrics. Beginning with 1917, the woolen and worsted industry of the United States operated under intense pressure, until the Armistice, to provide for the army.

The close of the war found both the United States and the United Kingdom badly overstocked with raw wool, which had been accumulated to provide for military requirements for a war the duration of which could not be foreseen. Large amounts of wool had accumulated in the chief producing countries because of disorganization of ocean transportation, and because of the elimination from the market of a group of consuming countries whose annual imports of wool had averaged nearly 1,200,000,000 pounds just before the war. It was expected that post-war demand for woolen and worsted goods at home and abroad would enable the United States and the United Kingdom to utilize their accumulated wool advantageously, and that those countries which had long been cut off from supplies would absorb the overstocks of wool accumulated in producing countries.

Such did not prove to be the case. The amount retained for consumption during and since the war cannot, therefore, be accepted as a measure of actual consumption. In Table E, production of wool and net exports or imports are shown as far as available for the years 1919, 1920 and 1921 for those countries whose position in relation to the international wool market from 1909 to 1913 was shown in Table D. No attempt has been made to arrive at a consumption figure.

TABLE E—INTERNATIONAL TRADE IN WOOL IN 1919, 1920 AND 1921

(in thousands of pounds)

Country	1919 Production	1919 Net Imports	1919 Net Exports	1920 Production	1920 Net Imports	1920 Net Exports	1921 Production	1921 Net Imports	1921 Net Exports
Exporting									
Algeria	33,184	...	14,203	33,184	...	11,586	33,184	[1]	[1]
Argentina	315,000	...	339,154	308,560	...	[2]216,403	300,000	...	[2]351,972
Australia and Tasmania	725,208	...	564,309	536,542	...	[2]637,237	536,542	...	[2]479,301
British India	60,000	...	[3]12,291	60,000	...	[4]9,607	60,000	...	[5]18,578
British South Africa	100,000	...	200,981	127,177	...	125,612	120,000	...	[2]247,548
Chile	26,000	...	27,315	33,069	...	29,656	26,000	[1]	[1]
China	50,000	...	[2]56,705	50,000	...	[2]20,147	50,000	[1]	[1]
New Zealand	228,000	...	274,242	181,480	...	162,290	181,480	...	158,715
Persia	12,146	[1]	[1]	12,146	[1]	[1]	12,146	[1]	[1]
Peru	[1]	...	11,305	9,420	...	[2]7,434	12,000	[1]	[1]
Spain	52,000	...	12,356	142,000	...	10,358	165,347	...	3,144
Uruguay	90,000	...	[2]145,742	100,000	...	[2]69,248	110,000	...	[2] [6]89,962
Importing									
Austria and Hungary	41,600	[1]	[1]	[1]	[7]2,412	...	[7]1,840	[1]	[1]
Belgium	[1]	72,909	...	825	122,640	...	1,226	56,521	...
Canada	15,000	...	2,065	24,423	5,979	...	24,050	5,894	...
France	50,000	339,212	...	39,400	329,102	...	39,600	277,442	...
Germany	25,600	[1]	[1]	37,278	121,549	...	42,975	217,935	...
Japan	[1]	50,970	...	[1]	[8]70,571	...	[1]	29,889	...
Netherlands	[1]	12,520	...	5,500	8,554	...	5,500	10,952	...
Norway	[1]	5,339	...	7,247	2,401	...	4,409	[9]1,114	...
Russia	[10]195,000	[1]	[1]	[10]195,000	[1]	[1]	[10]195,000	[1]	[1]
Sweden	[1]	[8]17,816	...	5,354	11,036	...	4,720	9,813	...
Switzerland	[1]	10,098	...	1,049	10,083	...	800	12,139	...
United Kingdom	118,000	962,779	...	100,000	694,599	...	100,000	427,546	...
United States	313,638	437,364	...	302,207	238,137	...	273,064	317,134	...

[1]Not available. [2]Total exports. Figures for imports which are usually negligible are not available. [3]Figures for fiscal year ending March, 1920. [4]Figures for fiscal year ending March, 1921. [5]Figures for first 8 months of fiscal year ending March, 1922. [6]Figures for first 8 months of calendar year. [7]Figures for Austria only. [8]Gross imports; figures for exports not available. [9]Figures for first 11 months of the calendar year. [10]Estimated.

WOOL CONSUMPTION IN THE UNITED STATES AND THE UNITED KINGDOM

Prior to 1914, the woolen and worsted industry of the United Kingdom was the foremost of the world, not only from the standpoint of reputation for quality, but from the standpoint of wool consumed, physical equipment, and the number of persons employed in the industry. Table D shows that the average amount of wool available for consumption during the five-year period 1909 to 1913 in the United Kingdom was 644,925,000 pounds, while the corresponding average for the United States was 516,937,000 pounds. Various estimates of consumption have been made during the war and post-war years for both countries. Comparisons are only of limited value, however, because of confusion as to whether all or part of the reported consumption is on a clean basis and no official data are available for the United Kingdom. Table F shows consumption in the United States from 1914 to date. It is clear from the table that American mill consumption when operation is at capacity is a good deal higher than the average for the five years immediately preceding the war.

TABLE F—WOOL CONSUMPTION IN THE UNITED STATES, 1914 TO 1921[1]

Year	Pounds (in thousands)
1914	502,857
1915	615,914
1916	725,391
1917	768,272
1918[1]	741,719
1919	626,885
1920	578,838
1921	650,273

[1]Figures for 1914 to 1917 inclusive represent wool in condition in which purchased; figures for 1918 to 1921 have been reduced to a grease basis.

Consumption of wool in the United States by classes and by grades, from 1918 to 1921, is shown in Table G.

TABLE G—CONSUMPTION OF WOOL IN THE UNITED STATES BY GENERAL CLASSES, 1918 TO 1921.

Class and grade	Quantity (in thousands of pounds) 1918	1919	1920	1921	Per cent. of total consumption 1918	1919	1920	1921
Fine								
Domestic	72,584	108,024	72,716	78,817	9.79	17.23	12.56	12.12
Foreign	79,168	101,727	92,417	54,750	10.67	16.23	15.97	8.42
Total	151,752	209,751	165,133	133,567	20.46	33.46	28.53	20.54
One-half blood								
Domestic	67,132	69,724	52,910	64,166	9.05	11.12	9.14	9.87
Foreign	46,697	42,000	35,056	18,740	6.30	6.70	6.06	2.88
Total	113,829	111,724	87,966	82,906	15.35	17.82	15.20	12.75
Three-eighths blood								
Domestic	74,912	69,190	63,512	71,891	10.10	11.04	10.97	11.06
Foreign	52,229	35,280	37,642	28,101	7.04	5.62	6.50	4.32
Total	127,141	104,470	101,154	99,992	17.14	16.66	17.47	15.38
One-fourth blood								
Domestic	67,535	51,016	49,522	69,798	9.10	8.14	8.56	10.73
Foreign	182,488	53,847	62,824	61,711	24.60	8.59	10.85	9.49
Total	250,023	104,863	112,346	131,509	33.70	16.73	19.41	20.22
Low or Lincoln								
Domestic	8,190	4,006	4,589	5,712	1.10	.64	.79	.87
Foreign	44,749	19,705	15,108	11,095	6.04	3.14	2.61	1.71
Total	52,939	23,711	19,697	16,807	7.14	3.78	3.40	2.58
Carpet, foreign	41,965	68,182	74,616	65,001	5.66	10.88	12.89	10.00
Grade not stated								
Domestic	2,790	2,691	8,045	68,763	.38	.43	1.39	10.58
Foreign	1,280	1,493	9,881	51,728	.17	.24	1.71	7.95
Total	4,070	4,184	17,926	120,491	.55	.67	3.10	18.53
Total								
Domestic	293,143	304,651	251,294	359,147	39.52	48.60	43.41	55.23
Foreign	448,576	322,234	327,544	291,126	60.48	51.40	56.59	44.77
Grand total	741,719	626,885	578,838	650,273	100.00	100.00	100.00	100.00

[1]Grease basis: pulled and scoured wool reduced to grease equivalent.

The relative importance of the industries of the United States and the United Kingdom may be compared on the basis of equipment for spinning and weaving, and the number of persons employed in the industry. Data for the woolen and worsted equipment of both countries are shown in Table H. It was estimated that about 73 per cent. of the total amount of wool consumed in the United Kingdom in 1917 was used by the worsted trade,

while in the United States in 1919, consumption in worsted manufactures represented about 76 per cent. of total consumption.

TABLE H—MACHINERY EQUIPMENT OF WOOL MANUFACTURING INDUSTRIES

FOR LATEST YEARS FOR WHICH STATISTICS ARE AVAILABLE[1]

Country	Year	No. of mills	Sets of cards	Combing machines	Spindles Woolen	Spindles Worsted	Doubling and Twisting Spindles	Looms
United States.....	1919[2]	850	7,075	2,294	2,019,553	2,903,503	771,117	75,729
United Kingdom..	1918[3]	2,218	6,130	2,474	3,061,085	3,609,545	1,352,196	120,900
Germany.........	...	...	...	...	...	...	...	...
France..........	...	...	...	...	...	...	...	...
Belgium.........	1920	...	503	...	360,175	348,130	21,659	6,826
Argentina........	1920	...	...	...	49,950		...	...
Austria..........	1921	39	...	...	48,500	130,880	...	1,156
Australia.........	1917	27	...	...	...	...	...	...
Czechoslovakia...	1920	...	...	...	1,596,000	450,000	...	34,455
Italy............	1918[2]	592	3,989	423	520,795	435,350	139,784	19,178
New Zealand.....	1919	10	...	...	...	...	...	34,000

[1]Reference Book of the National Association of Wool Manufacturers.

[2]Woolen and worsted goods industries only.

[3]Statistical Report of Bradford Chamber of Commerce—woolen and worsted mills only.

The number of persons employed in an industry in any country is not necessarily an indication of its size in comparison with the same industry in another country, as a higher average of skill may be offset by the use of better and more nearly automatic machinery, while the relatively higher speed at which American operatives work as compared with the operatives of other countries is also a factor. Comparison from this viewpoint is nevertheless of interest. Approximately 285,000 persons are employed in the British industry. In 1914, the American industry employed an average of 159,000 wage earners, and 166,787 operatives were reported by the United States census of 1919.

Apparently the productive capacity of the woolen and worsted industry of the United States is somewhat below that of the United Kingdom. Although certain classes of British fabrics have a clearly recognized superiority,

there now seems to be no intrinsic reason to prevent the development of a domestic industry surpassing that of Great Britain. While American mills meet an exceedingly severe competition in foreign markets, the domestic market alone can absorb a gradually expanding output.

PRESENT SITUATION IN THE WOOL MANUFACTURE OF FRANCE

The French industry is primarily engaged in the manufacture of worsteds. It centers in the towns of Roubaix and Turcoing in the Department of the North. The industry is also of considerable importance in the departments of the Marne, the Aisne, the Ardennes, and Normandy, while Mazamet, in the Department of Tarn, has been one of the most famous wool-pulling centers of the world. Before the war, about 175,000 persons were employed in the woolen and worsted manufacture of France, but four-fifths of the plants were in the devastated and occupied areas, so that the industry emerged from the war in a disorganized condition.

As a partial offset to war losses, France gained the industry of Alsace-Lorraine, which before the war employed somewhat less than 25,000 persons. In a physical sense, the French industry of the invaded regions has been gradually rehabilitated. If operated at capacity, these regions could now considerably exceed half of pre-war production. However, unsatisfactory general conditions, not only in France but elsewhere, have delayed a return to normal activity. The United States Trade Commissioner at Paris estimated French wool consumption in 1920 as 360,000,000 pounds, in the condition in which purchased. Equivalent on scoured basis is not known.

GERMAN WOOL CONSUMPTION

Prior to 1914, the German wool manufacture was fourth in importance, when measured by wool consumption, as indicated by the amount retained in the country. The industry is distributed throughout Germany, in marked contrast to its localization in the United States, the United Kingdom and France. Prior to 1914, it employed a little less than 250,000 persons, of whom some 25,000 were in Alsace-Lorraine. Aside from the loss of that portion of the industry, the German woolen and worsted manufacture was not much affected by the war or the Peace Treaty, but it had been practically shut off from raw materials for four years. The decline of the mark has put Germany in an advantageous position for the export of wool manufactures, but at a disadvantage as regards the purchase of raw materials. However, the industry has been very active in recent months, and wool consumption for 1921 probably reached about two-thirds of normal, or 300,000,000 pounds.

OTHER EUROPEAN COUNTRIES

The other important wool-manufacturing countries of Europe, prior to 1914, were Belgium, Austria-Hungary, and Russia, the textile industries of the two latter countries being now largely transferred to Poland and Czechoslovakia. Belgium is obliged to import practically all of the raw materials used, of which about one-third is Australian wool, the remainder coming chiefly from the River Plate and South Africa. While the weaving of woolens and worsteds is an important industry, the location of Belgium has also enabled its factories to do work

for the industries of other countries. Somewhat less than half of the carded yarn produced in the country is normally consumed by Belgian weaving establishments. Prior to the war, Germany was the heaviest buyer. Yarn is also sent to France and Great Britain, although some heavy carded yarn is imported into Belgium from the latter country for the manufacture of common carpets and hosiery. There is also much equipment in Belgium for sorting, scouring, carbonizing, and otherwise conditioning wool, which is put through these plants before further transportation, in order to lessen freight charges. During the five years 1909 to 1913, exports of wool from Belgium were about two-thirds of total imports on a straight weight basis, making no allowance for the fact that a much higher proportion of exports than of imports was undoubtedly clean wool. Part of the exports represent mere transshipment, however.

The center of the Belgian wool manufacture is Verviers. While the machinery was somewhat damaged during the period of occupation, it is now in fair condition for operation.

During the five years 1909 to 1913, net wool imports into Austria-Hungary were about 64,000,000 pounds per year. At least 75 per cent. of the wool manufacture of the former empire was located in the territory now embraced in Czechoslovakia, which acquired possession of every important textile center of the old empire except Bialic-Biala, which went to Poland. Czechoslovakian purchases of raw wool have naturally been made where they were made before the war, primarily from Australia, South Africa, and South America. Wool consumption in 1920 was unofficially estimated at 23,000,000 pounds.

The Russian industry centered at Lodz, which is now in Poland, and in Moscow. The industry consumed a part of the merino wool produced in Russia, and Russian net imports from 1909 to 1913 averaged about 70,000,000 pounds per year. The Russian industry also consumed a good deal of coarse native wool for military supplies and for peasant use. The loss of the industry centering at Lodz, Warsaw and Kalisz, and complete disorganization as a result of political disturbances, have cut production of wool fabrics to a small part of the pre-war factory output. It was not expected that production in 1921 would be more than one-fourth of the needs of the people. It seems probable, however, that there is a considerable production of hand-made fabrics in the homes for household use.

Lodz is the center of the Polish industry. As to size and technical equipment the mills in that district are among the best on the Continent. Wool manufacturing is also important at Warsaw, Kalisz, and Bialystock, and in Bielsk. In a statement ascribed to the Polish Ministry of Industry and Commerce it was estimated that before the war the textile industry embraced within the present boundaries of Poland consumed about 217,000,000 pounds of wool a year, largely of low and medium grades. Other sources indicate that this figure is too high. Lack of raw materials and financial and political instability have militated against the rapid resumption of manufacturing activity in Poland.

JAPAN

The wool manufacture of Japan has developed very rapidly in the last ten years. Only a very small amount

of wool is produced in the country, so that for practical purposes imports are identical with consumption. During the five years 1909 to 1913, they averaged about 10,000,000 pounds annually. In 1913, however, imports of raw wool were 12,000,000 pounds, in 1919, 51,000,000 pounds and in 1920, 71,000,000 pounds. In addition, about 4,000,000 pounds of tops are ordinarily imported. Japanese imports in 1920 proved to be in excess of demand, because of a decline in exports of wool manufactures and in domestic buying power, and in 1921 only 30,000,000 pounds were imported.

The chief Japanese product is mousseline de laine, a light dress goods which is either left plain or printed in oriental designs. This fabric requires the best grades of wool. Second in importance is the manufacture of wool materials for military use. For these, half merino and half Chinese wool is used. Products of this class were reported in the spring of 1921 as constituting about 30 per cent. of the total output of the industry. On the basis of grades of wool used, Japanese production at that date was reported as divided about as follows: fine, count 64 and above, 60 per cent.; medium, counts 56 to 64, 30 per cent., and other grades, 10 per cent.

WOOL MANUFACTURE IN OTHER COUNTRIES

The war stimulated the wool manufacture of a number of countries in which the industry had previously been little developed, and it seems likely that these gains will be held, behind the barrier of protective tariff if need be, at least in those countries able to supply all, or part, of their raw materials. Significant development of the woolen and worsted industry has taken place in Brazil,

Argentina and Canada, and a beginning has been made in Australia and New Zealand. Canada has exported important amounts of wool manufactures.

This tendency toward establishment of the woolen and worsted industry in countries heretofore dependent primarily on imported fabrics is a perfectly logical step in the industrialization of those countries. Because of a limited labor supply, the growth of the industry will undoubtedly be slow, but it is not inconceivable that in the course of

TABLE I—WORLD PRODUCTION OF WOOL, 1919

Country	Total Production	Merino	Crossbred and English	Carpet, etc.
	(in millions of pounds)			
British Empire				
Australia	653	457	196	...
British India	60	...	...	60
Canada	15	...	15	...
Falkland Islands	3	...	3	...
New Zealand	228	9	219	...
South Africa	100	97	...	3
United Kingdom	118	...	118	...
Total	*1,177*	*563*	*551*	*63*
Principal European Countries				
Austria-Hungary	42	8	34	...
France	50	10	40	...
Germany	26	5	21	...
Greece	16	...	...	16
Italy	35	26	9	...
Portugal	7	3	3	1
Russia	320	20	...	300
Spain	52	25	25	2
Turkey and the Balkan States	91	...	...	91
Total	*639*	*97*	*132*	*410*
South America	480	80	360	40
United States	314	157	157	...
Other countries	281	...	...	281
Total	*1,075*	*237*	*517*	*321*
Grand total	2,891	897	1,200	794

years the extreme localization which now characterizes the woolen and worsted industry of the world may tend to disappear.

THE WORLD'S WOOL SUPPLY IN RELATION TO GRADES

Merino wool, which constitutes a little less than one-third of all wool produced in the world, is essential for the production of many of the finer kinds of wool fabrics. Two-thirds of the merino clip of the world is produced within the British Empire. Table I, from a report of the United States Tariff Commission entitled "The Wool-Growing Industry," issued in 1921, summarizes the world's wool clip for 1919, according to broad general classes. The data are necessarily approximate and differ somewhat from statistics compiled from other sources, but it is believed that the table indicates in a general way the international situation as to the main classes of wool. Conditions have not changed materially since 1919.

DESTINATION OF WOOL EXPORTS FROM CHIEF EXPORTING COUNTRIES

About 95 per cent. of the Australian wool clip is exported. Before the war, the United Kingdom took more than one-third of the total and the Continent about three-fifths, while only 1 or 2 per cent. came directly to the United States. However, a considerable amount of Australian wool reached this country through the United Kingdom. Exports to Italy showed a marked increase during the war, but Imperial purchase, the blockade and shortage of shipping cut off Australian shipments to other European countries to such an extent that the Continent did not receive more than 10 per cent. of Australian ex-

ports. Between 70 and 80 per cent. of that part of the clip exported went to the United Kingdom during that period, and the United States received 10 to 15 per cent. It is not yet possible to determine whether or not the United States will continue to be a more important factor in the direct export trade from Australia than before the war.

Prior to 1914, about 90 per cent. of all New Zealand wool went to the United Kingdom. During the war, exports to the United Kingdom decreased, and the share sent to the United States increased.

As in the case of Australia, the war made radical changes in the South African wool trade. Before the war, the United Kingdom took more than half the clip, and British takings reached 72 per cent. of total exports in 1915. They then declined sharply, exports to the United States amounting to half the total in 1917 and 1918, while Japan took nearly one-fourth. Since that time, however, exports to the United States have declined in relative importance. Exports to Japan have also declined heavily.

France was the heaviest buyer of Argentine wool prior to 1913, and Germany was second in importance, but in that year the position of the two countries was reversed. Large quantities were also exported to Belgium, the United Kingdom and the United States. In 1915, the United States became the dominant factor in the Argentine market, taking about half of total exports, and this condition continued through 1918. Unofficial data for 1920 and 1921 indicate, however, that American purchases declined heavily. Belgium was the heaviest buyer in 1920, taking more than one-third of total exports. Undoubtedly Belgian purchases were designed in large

TABLE J—EXPORTS OF WOOL FROM AUSTRALIA BY PRINCIPAL COUNTRIES OF DESTINATION FROM 1913 TO 1921[1]

[Figures for years 1913 to 1918–19 from tables compiled by United States Tariff Commission. Scoured wool was reduced to a grease equivalent on the assumption that the weight of scoured wool is equal to one-half the weight of wool in the grease. Figures for 1919–20 and 1920–21 are from official sources.]

Country	1913	1914–15	1915–16	1916–17	1917–18	1918–19	1919–20	1920–21
				(in thousands of pounds)				
United Kingdom	237,740	415,958	277,524	377,281	257,608	558,805	538,597	369,779
France	197,392	17,096	16,128	14,287	5,800	3,774	32,453	35,572
Germany	114,341	6,532	...	308	...	...	...	9,275
United States	14,915	70,847	170,980	16	60,318	74,697	33,527	47,144
Belgium	62,422	4,826	...	...	...	...	27,863	47,318
Italy	6,155	19,502	53,008	30,912	18,594	10,037	44,597	17,113
Japan	14,329	34,952	49,725	27,002	12,478	12,215	16,282	21,549
Other countries	13,043	4,139	3,660	2,790	23,878	16,778	41,117	6,241
Total	660,337	573,852	571,025	452,596	378,676	676,306	734,436	553,991

[1]A small amount of tops included.

TABLE K—EXPORTS OF WOOL FROM SOUTH AFRICA BY PRINCIPAL COUNTRIES OF DESTINATION FROM 1913 TO 1921

[Figures for years 1913 to 1919 were compiled by the United States Department of Agriculture. Figures for 1920 and 1921 are from official documents but were reduced to a grease basis by a slightly different process than that employed in the figures for earlier years. For all practical purposes, however, the figures are on a comparable basis.]

Country	1913	1914	1915	1916	1917	1918	1919	1920	1921
				(in thousands of pounds)					
United Kingdom.....	96,029	88,726	133,804	107,538	23,314	35,810	96,462	48,065	107,549
Canada............	...	...	33	39	633	4,149	958	...	82
Belgium...........	20,695	10,718	...	...	...	...	12,662	18,202	29,981
France.............	4,898	1,970	...	...	60	262	9,588	1,251	21,285
Germany...........	61,124	39,602	...	...	...	...	...	7,607	51,575
Italy...............	925	...	309	...	...	1,528	43	1,542	2,371
Japan..............	...	...	16	83	39,307	30,878	39,801	35,454	7,339
United States.......	222	1,229	52,091	48,236	76,531	70,990	71,503	20,871	20,462
Other countries......	4	15	...	...	...	326	574	2,128	3,609
Total..........	183,897	142,260	186,253	155,896	139,845	143,943	231,591	135,120	244,253

TABLE L—EXPORTS OF WOOL FROM ARGENTINA FROM 1913 TO 1921 BY PRINCIPAL COUNTRIES OF DESTINATION

[From figures compiled by United States Tariff Commission. Figures for 1920 and 1921 are taken from the Review of the River Plate and may not be exactly comparable.]

Country	1913	1914	1915	1916	1917	1918	1919	1920	1921
				(in thousands of pounds)					
Germany	87,551	66,989	...	...	...	...	...	25,164	116,895
Belgium	22,249	19,374	...	...	...	...	30,890	105,594	35,834
United States	19,520	37,699	113,782	158,297	196,011	154,097	104,221	70,319	65,771
France	81,270	52,456	39,603	24,830	26,834	38,794	76,314	13,928	54,415
Italy	6,486	15,068	43,506	23,486	19,345	15,445	17,786	17,798	10,711
United Kingdom	40,626	59,291	36,155	28,431	20,011	4,171	31,391	40,987	60,120
Japan	...	...	...	...	5,258	3,849	...	...	[1]
Other countries	7,026	7,656	26,369	24,343	13,480	12,669	66,375	18,734	6,713
Total	264,728	258,533	259,415	259,387	280,939	229,025	326,977	292,524	350,459

[1] Not available.

part for reëxport to other Continental countries. In 1921, Belgian purchases fell off and Germany took about one-third of total exports.

Tables J, K and L show distribution of exports of wool from Australia, South Africa and Argentina in 1913, during the war, and for the post-war years as far as data are available.

SOURCES OF THE RAW WOOL SUPPLY OF THE UNITED STATES

In the years immediately preceding 1914, the woolen and worsted industry of the United States consumed annually about 500,000,000 pounds of wool (in condition in which purchased). Domestic wool production constituted about three-fifths of the total. While it is as yet too early to determine what part of the expansion in wool

TABLE M—IMPORTS OF CLOTHING WOOLS INTO THE UNITED STATES, 1909 TO 1921, BY PRINCIPAL COUNTRIES OF ORIGIN

Country	[1]1909-13 (5-yr. aver.)	[1]1914-18 (5-yr. aver.)	[2]1918	[2]1919	[2]1920	[2]1921
		(in thousands of pounds)				
Belgium	1,471	1,517	...	204	1,250	543
France	184	1,319	117	379	587	378
Germany	311	180	...	...	1	445
Russia in Europe	...	2	...	1,151	180	...
Turkey in Europe	1	6	...	318	27	...
United Kingdom	33,036	23,205	39	14,704	28,968	21,406
Canada	149	1,336	2,718	12,067	7,629	3,089
Argentina	24,503	111,096	203,238	118,854	71,910	68,198
Chile	132	7,267	10,887	11,959	14,514	8,107
Ecuador	[3]	283	1,162	176	46	...
Peru	...	2,025	3,900	2,273	884	171
Uruguay	3,592	16,523	17,656	49,931	29,768	29,173
Australia	18,581	53,815	65,118	46,035	37,372	42,410
New Zealand	4,463	5,240	6,276	14,234	26	8,342
China	1	6,241	10,506	8,529	525	8,455
British India	...	43	2	66	33	[3]
Persia	...	...	...	...	...	...
Russia in Asia	...	8	81	77	612	...
Turkey in Asia	22	6	...	141	...	2
British South Africa	65	33,061	51,064	51,466	17,296	15,694
Other countries	33	3,543	1,147	1,536	764	1,454
Total	86,544	266,716	373,911	334,100	212,392	207,867

[1]Fiscal years ending June 30.
[2]Calendar year.
[3]Less than 1,000 pounds.

consumption which took place during the war years will prove permanent, it seems a fair assumption that normal consumption of wool by American mills is now somewhat in excess of 600,000,000 pounds a year.

The domestic clip of the United States has not varied far from 300,000,000 pounds in thirty-five years, so that increased consumption must be taken care of by increased imports. The sources of the foreign wools spun and woven in American mills are therefore of fundamental interest from the standpoint of the future of the wool-manufacturing industry. The tables which follow show separately for the three classes of wools as reported for tariff purposes, and for the three classes combined, average imports of wool into the United States from the more important countries, for the five fiscal years ending June

TABLE N—IMPORTS OF COMBING WOOLS INTO THE UNITED STATES, 1909 TO 1921, BY PRINCIPAL COUNTRIES OF ORIGIN

Country	[1]1909–13 (5-yr. aver.)	[1]1914–18 (5-yr. aver.)	[2]1918	[2]1919	[2]1920	[2]1921
	(in thousands of pounds)					
Belgium	1	...	...	...	...	59
France	[3]	4	...	9	33	[3]
Germany	9	...	...	...	...	6
Russia in Europe	44	29	...	...	...	...
Turkey in Europe	762	129	...	1,632	1,192	216
United Kingdom	15,535	5,020	60	3,383	3,063	4,715
Canada	1,008	6,174	710	651	199	115
Argentina	1,174	3,060	2,357	2,087	1,347	5,570
Chile	[3]	31	70	637	319	...
Ecuador	...	12	...	...	...	...
Peru	836	206	1,312	1,109	1,249	628
Uruguay	65	73	...	341	358	631
Australia	8	124	...	32	2	25
New Zealand	70	...	...	...	...	962
China	1	419	1,206	643	2,864	914
British India	[3]	6	...	...	27	...
Persia	...	...	...	...	...	...
Russia in Asia	...	...	...	253	98	...
Turkey in Asia	10	...	...	...	92	...
British South Africa	8	73	4,753	3,997	369	915
Other countries	162	279	57	71	143	143
Total	19,693	15,639	10,525	14,845	11,355	14,899

[1]Fiscal years ending June 30.
[2]Calendar year.
[3]Less than 1,000 pounds.

Table O—Imports of Carpet Wools into the United States, 1909 to 1921, by Principal Countries of Origin

Country	[1]1909–13 (5-yr. aver.)	[1]1914–18 (5-yr. aver.)	[2]1918	[2]1919	[2]1920	[2]1921
		(in thousands of pounds)				
Belgium	167	6	...	...	176	218
France	3,474	659	[3]	378	140	1,275
Germany	2,338	662	...	...	...	968
Russia in Europe	13,520	3,991	22	411	324	...
Turkey in Europe	1,751	540	...	2,932	2,349	113
United Kingdom	24,915	12,248	...	19,045	6,380	37,839
Canada	6	49	[3]	98	60	105
Argentina	4,179	12,193	15,068	14,045	1,765	10,181
Chile	60	2,566	8,197	13,274	3,716	86
Ecuador	...	269	871	408	85	...
Peru	...	1,578	3,136	1,541	360	4
Uruguay	80	1,064	1,026	7,031	488	2,352
Australia	...	35	...	...	...	16
New Zealand	...	...	...	...	...	...
China	33,282	31,885	31,198	29,814	11,763	37,183
British India	4,191	1,426	10	66	366	1,374
Persia	956	110	...	...	...	511
Russia in Asia	4,692	2,360	2,718	1,129	2,327	10
Turkey in Asia	7,267	1,584	...	1,353	2,810	400
British South Africa	137	3,135	4,442	2,386	674	1,517
Other countries	4,083	4,370	2,604	3,037	2,087	3,748
Total	105,098	80,730	69,292	96,948	35,870	97,900

[1]Fiscal years ending June 30. [2]Calendar year. [3]Less than 1,000 pounds.

Table P—Total Imports of Wool into the United States, 1909 to 1921, by Principal Countries of Origin

Country	[1]1909–13 (5-yr. aver.)	[1]1914–18 (5-yr. aver.)	[2]1918	[2]1919	[2]1920	[2]1921
		(in thousands of pounds)				
Belgium	1,639	1,523	...	204	1,426	820
France	3,658	1,982	117	766	760	1,653
Germany	2,658	842	...	...	1	1,419
Russia in Europe	13,564	4,022	22	1,562	504	...
Turkey in Europe	2,514	675	...	4,882	3,568	329
United Kingdom	73,486	40,473	99	37,132	38,411	63,960
Canada	1,163	7,559	3,428	12,816	7,888	3,309
Argentina	29,856	126,349	220,663	134,986	75,022	83,949
Chile	192	9,864	19,154	25,870	18,549	8,193
Ecuador	[3]	564	2,033	584	131	...
Peru	836	3,809	8,348	4,923	2,493	803
Uruguay	3,737	17,660	18,682	57,303	30,614	32,156
Australia	18,589	53,974	65,118	46,067	37,374	42,451
New Zealand	4,533	5,240	6,276	14,234	26	9,304
China	33,284	38,545	42,910	38,986	15,152	46,552
British India	4,191	1,475	12	132	426	1,374
Persia	956	110	...	...	...	511
Russia in Asia	4,692	2,368	2,799	1,459	3,037	10
Turkey in Asia	7,299	1,590	...	1,494	2,902	402
British South Africa	210	36,269	60,259	57,849	18,339	18,126
Other countries	4,278	8,192	3,808	4,644	2,994	5,345
Total	211,335	363,085	453,728	445,893	259,617	320,666

[1]Fiscal years ending June 30. [2]Calendar year. [3]Less than 1,000 pounds.

30, 1909, to 1913, average imports for the five fiscal years 1914 to 1918, and for the calendar years 1918, 1919, 1920 and 1921. It will be observed that imports for the first six months of 1918 are included twice in these tables. The same list of countries is shown for each class of imports, in order to facilitate combination into the table showing total wool imports of all classes.

PRICES

The wool market was violently affected, both by war conditions and post-war speculation. Government control of the British and Australasian clips was established at a fairly early stage of the struggle, and the Government of the United States established an effective control in the domestic wool market at the close of 1917. Formal price fixing began on May 1, 1918.

The effects of post-war speculation were accentuated by general disorganization in the international wool trade resulting from different dates of decontrol in various countries; the accumulations of wool in producing countries as a result of the cutting off of nearly all the Continent from the sources of supplies, as well as lack of shipping space; the disruption of exchanges, and some other factors.

Wool prices always vary as between countries, because of tariffs, transportation charges and other local conditions, but the general trend is of necessity fairly uniform. While prices in the various markets have differed even more than usual due to abnormal conditions, the price at the American seaboard is nevertheless a fair picture of the course of events in the international wool market during recent years. Table Q shows prices of two grades of domestic wool at Boston from 1913 to June, 1922, and

prices of a number of representative imported and domestic grades at the Atlantic seaboard from July, 1919, to June, 1922. All prices are on a clean basis.

PRESENT CONDITIONS IN THE INTERNATIONAL WOOL MARKET

Australasian Stocks.—Consideration of the outstanding facts as to international supply of and demand for wool

TABLE Q—PRICE OF RAW WOOL AT THE ATLANTIC SEABOARD, 1913 TO JUNE, 1922

[Prices are for the available date nearest the fifteenth of each month.]

PART I

Year and month	Clean basis Boston: Ohio fine delaine (dollars per pound)	Clean basis Boston: Ohio ¼ blood (dollars per pound)
1913		
January......	.72	.54
April.........	.66	.46
July..........	.58	.42
October......	.58	.40
1914		
January......	.56	.39
April.........	.59	.42
July.........	.68	.47
October......	.61	.47
1915		
January......	.66	.52
April.........	.73	.62
July..........	.73	.66
October......	.72	.62
1916		
January......	.76	.66
April.........	.85	.68
July.........	.82	.71
October......	.86	.73
1917		
January......	1.10	.85
April.........	1.30	1.01
July.........	1.75	1.29
October......	1.85	1.31
1918		
January......	1.85	1.33
April.........	1.85	1.35
July.........	1.85	1.32
October......	1.85	1.32
1919		
January......	1.65	1.08
April.........	1.75	.93
July.........	2.02	1.14
October......	1.98	1.10
1920		
January......	2.30	1.07
April.........	2.35	1.10
July.........	1.74	.79
October......	1.30	.60
1921		
January......	1.05	.45
April.........	.92	.45
July.........	.83	.40
October......	.86	.44
1922		
January......	1.03	.54
February.....	1.20	.70
March.......	1.20	.66
April.........	1.12	.62
May.........	1.25	.68
June.........	1.45	.76

TABLE Q—PRICE OF RAW WOOL AT THE ATLANTIC SEABOARD, 1919 TO JUNE, 1922—CONTINUED

PART II

CLEAN BASIS AT ATLANTIC SEABOARD

Year and month	Aver. fine territory	Aver. ½ blood territory	Aver. ⅜ blood territory	Ohio fine delaine	Ohio ¼ blood	Aver. 64's Australian	Aver. fine combing Cape	South American merino	South American 3's	South American 4's	South American 5's
	(dollars per pound)										
1919											
July	1.50	[1]	[1]	1.60	1.05	1.65	1.50	1.40	.80	.68	.60
October	1.70	[1]	[1]	1.90	1.20	1.85	1.70	1.60	.75	.63	.56
1920											
January	1.85	[1]	[1]	2.40	1.10	2.60	2.10	1.75	.65	.55	.43
April	1.80	[1]	[1]	2.40	1.05	2.40	2.10	1.70	.60	.50	.40
July	1.40	[1]	[1]	1.60	.65	1.70	1.50	1.40	.50	.40	.32
October	1.00	.95	.65	1.25	.60	1.00	1.00	.90	.40	.30	.20
1921											
January	.70	.65	.50	.90	.43	.75	.60	.50	.26	.20	.16
April	.70	.65	.50	1.00	.43	.85	.70	.55	.25	.20	.16
July	.70	.60	.48	.87	.38	.85	.70	.60	.25	.20	.16
October	.70	.60	.48	.85	.40	.90	.70	.60	.25	.20	.16
1922											
January	.90	.78	.66	1.05	.58	1.25	1.00	.80	.45	.36	.25
February	1.00	.85	.70	1.10	.63	1.25	1.00	.90	.50	.39	.30
March	1.00	.85	.70	1.10	.63	1.25	1.00	.90	.50	.39	.30
April	.90	.75	.65	1.10	.60	1.20	.90	.85	.50	.39	.30
May	1.20	1.00	.85	1.25	.75	1.35	1.20	1.10	.60	.55	.40
June	1.25	1.10	.90	1.30	.80	1.35	1.20	1.15	.67	.60	.42

[1]Not available.

makes it obvious that an accumulation of wool in the main producing countries from 1914 to 1921 was inevitable. Prior to 1914, annual net imports of wool into Austria-Hungary, Belgium, France, Germany and Russia averaged about 1,200,000,000 pounds. While these countries undoubtedly received a certain amount of wool, at least during the earlier war years, they did not get much. The close of the war found their industries disorganized and their currencies depreciated, so that while they have all been buying wool since 1918, with the exception of Belgium their imports have remained below pre-war amounts. Meanwhile, from causes inherent in the wool-growing industry, already discussed, there has been no marked curtailment of production.

The main accumulation of wool was in the United Kingdom and in the British dominions. Beginning with November, 1916, the British Government arranged to take over the Australian and New Zealand clips, and continued to purchase them for three seasons thereafter. Although there was no arrangement for taking over the entire South African clip of any year, the British Government also bought large quantities of wool there. The growers had been paid for this wool but this did not alter the situation in the least, as far as stocks were concerned, the net result being that on June 30, 1920, the British Government was the owner of 2,905,544 bales. Although exact data are not available as to the origin of wools included in this total, apparently about 2,000,000 bales were Australian, 800,000 bales New Zealand, and the remainder South African and other wools. It was clear that in fairness to the British Government this wool would have to be sold, thus bringing it into competition with the

current clips, and it was arranged that any profits over the original purchase price should be divided between the British Government and the growers in equal shares. Although by December 31, 1920, these stocks had been reduced by about 300,000 bales, to 2,611,277 bales, of which all but 2,329 bales were Australian and New Zealand wools, at that date they represented nearly one-third of an ordinary annual world clip.

In disposing of this wool, it was necessary to take account of current clips. On June 30, 1921, it was estimated that including government-owned wools and the Australasian clips of 1920–21 and 1921–22, there would be available to the market a total of 5,950,000 bales. It was believed that if this enormous quantity of wool, amounting to practically two-thirds of a year's clip for the entire world, were all offered on a free market, demoralization would result. To handle the situation, the British-Australian Wool Realization Association, Ltd., popularly known to the wool trade as "Bawra," was formed. In an effort to stabilize the market, not only was this organization authorized to handle the government-owned wool, but after vain efforts to stabilize the price of the current clip by agreement among the growers, on May 9, 1921, the Commonwealth Government adopted a regulation forbidding the exportation of wool at a price lower than a rate of 8d per pound for greasy wool. This regulation was to be effective for six months, or until November, 1921.

On July 31, 1921, Sir John Higgins, speaking for "Bawra," outlined the situation as shown below. His estimates of the 1921–22 clip, and consequently the totals, have been revised according to later official estimates:

	Bales	
"Bawra" carryover wools		
Australian	1,489,000	
New Zealand	720,000	
Total		2,209,000
Cape and other wools		200,000
Unsold balance of 1920–21 clip		
Australian	500,000	
New Zealand	200,000	
Total		700,000
Clip of 1921–22 (estimated)		
Australian	1,900,000	
New Zealand	520,000	
Total		2,420,000
Grand total		5,529,000

Throughout 1921, these old and new wools were persistently fed to the market through auctions in Australia, New Zealand, London and Antwerp, the war wools being offered chiefly in London and on the Continent. On December 31, 1921, "Bawra" carryover of Australian and New Zealand wools amounted to 1,810,000 bales, a reduction of about 800,000 bales from December 31, 1920, and of 400,000 bales from July 31, 1921. In addition, "Bawra" held 80,000 bales of South African wool. Australasian estimates of stocks of Australian and New Zealand wools other than "Bawra" stocks are not available, but the United States Department of Agriculture estimated them at about 600,000 bales as of November 30, 1921. Apparently, the total stocks of Australasian wools at the end of 1921, including "Bawra" wools, the carryover from the clip of 1920–21, and the clip of 1921–22 were in excess of 4,500,000 bales or 1,500,000,000 pounds.

Although an attempt was made to have wool control continued at the expiration, on November 9, 1921, of the

Commonwealth regulation forbidding the exportation of greasy wool at a price below 8d per pound, this was not successful, except for a temporary extension to November 23. On that date, all forms of wool regulation expired in Australia, so that the Australian wool market is entirely free. "Bawra" stocks continued to decline rapidly during the first six months of 1922, being 1,291,000 bales on June 30. The organization will apparently continue to operate until this wool is finally disposed of.

Australasian Merinos and Crossbreds.—Notwithstanding an active demand for wool throughout the latter part of 1921, Australasian wool stocks are still very heavy. Both old and new merinos have moved well. On August 31, 1919, of the total stocks of Australasian wools held by the British Government, 1,202,023 bales, or 46 per cent., were merinos (including fine comebacks). On June 30, 1922, "Bawra" holdings of merinos were but 204,522 bales, or 16 per cent. of total "Bawra" stocks, and the organization expects that they will all be sold by the close of 1922. The movement of new wools has also been more active in the merino classifications than in other grades. The accumulation is primarily in crossbreds. "Bawra" stocks of crossbred wools on June 30, 1922, were 917,000 bales of which 18,000 bales were South African wools.

Stocks in Other Producing Countries.—Although during 1921 the British Government was compelled to purchase about 100,000 bales of the 1919–20 clip of South Africa to relieve the situation there, by June, 1922, the supply of fine grades in that country was practically exhausted. Wool stocks at the central markets of South America on January 1, 1922, were estimated at 37,000,000 pounds, compared with about 40,000,000 pounds on the corresponding

date of 1921. However, stocks at central markets are not total South American stocks, which may even yet be above normal, although much reduced from high levels.

Stocks in Consuming Countries.—According to the United States Department of Agriculture, stocks of wool in Great Britain, France, and Germany are small. Stocks of wool in the United States at the close of 1921, while adequate, were certainly not heavy. Table R summarizes government returns of stocks, reduced to grease equivalent, at the close of each year from 1917 to 1920, and on September 30, 1921. The government stocks were entirely disposed of in March, 1922.

TABLE R—STOCKS OF WOOL ON HAND HELD BY DEALERS, MANUFACTURERS, AND THE GOVERNMENT ON DECEMBER 31, 1917, TO 1921

December 31	Estimated equivalent grease wool Held by Dealers and manufacturers	Government	Total
	(in thousands of pounds)		
1917	544,977	[1]	[1]
1918	272,062	[1]	[2]
1919	475,000	117,416	592,416
1920	508,778	64,403	573,181
1921[3]	469,647	45,145	514,792

[1]Not reported.
[2]Total supply of grease, pulled and scoured wool estimated at 460,000,000 lbs.
[3]Returns for September 30, 1921.

THE OUTLOOK

Including the clip of the Australasian wool year 1921–22, which ends on June 30, 1922, Australasian wool supplies available for the calendar year 1922 are more than half as large as the average annual amount available from all sources for the international market during the five years 1909 to 1913, and they do not fall far short of twice the average annual Australasian exports for that period. If available supplies from sources other than Australasia are

normal, and there is no indication that such is not the case, it is apparent that supplies for 1922 are far in excess of pre-war requirements, and there seem to be no grounds for a reasonable expectation that demand from Europe will return even to the level of 1909 to 1913 in the immediate future.

Superficially, the conclusion might be drawn that further heavy declines in the price of raw wool might be anticipated. However, the situation as regards the "Bawra" wools, which constitute a large proportion of total Australasian supplies, is peculiar. The growers have been paid for this wool once, and the Association has now paid the last installment due on the outstanding priority certificates which were issued to growers in anticipation of the sale of the wool. Under these conditions it seems fairly certain that this wool will never be sold in a way to demoralize the market for the current or later clips. Until it is ultimately disposed of, however, it is a powerful factor in the international market. Another and equally powerful factor is the inability of consumers throughout the world to pay high prices for woolen and worsted goods.

Apparently disposal of the world's surplus of crossbreds still constitutes a problem. There is no surplus of merinos but it does not follow that there is likelihood of a shortage. A sustained demand for them at advancing prices is dependent on purchasing power adequate to maintain the consumption of high-priced wool fabrics, and this is not assured. Only after the lapse of years will the international wool market return to a condition of relative stability such as prevailed prior to the outbreak of the World War.

THE END